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CONDITIONS OF SURVIVAL: FREEDOM OF THOUGHT AND THE INTERNATIONAL COMMUNITY

THE General Assembly of the International Council of Scientific Unions has formulated clearly the duty of men of science to maintain a spirit of frankness, honesty, integrity and co-operation, and to work for international understanding; to promote the development of science in the way most beneficial to mankind and to exert their influence so far as possible to prevent its misuse; and to serve the community not only by their specialized work but also by assisting so far as they are able in the education of the public in the purposes and achievements of science. To assert that those duties and conditions cannot be realized under communism as we see it in Soviet Russia is not to assert that co-operation is impossible, but rather to clear the way to an understanding which is based on mutual respect. For if it is imperative to maintain uncompromisingly that surrender of national sovereignty is an essential and unescapable condition of the control of atomic energy and avoidance of the evils of atomic, biological or biochemical warfare, it is equally imperative that nothing should be left undone, consistent with that principle, to reassure the U.S.S.R. that they have nothing to fear from the American lead while the super-national authority is being established.

One of the more recent "Looking Forward" pamphlets on reconstruction issued by the Royal Institute of International Affairs helps to clarify thought at this point. Martin Wight concludes his survey of "Power Politics" with a section in which he points out that, though the tradition of an international community with a common standard of obligation and justice has faded, it has not altogether disappeared. It is the main influence that has modified and can yet modify the operations of power politics and can still be discerned in the preamble to the Charter of the United Nations. It must be remembered, too, that morality in international politics is not simply a matter of civilized tradition, but is equally the result of security—a truth that gives us the clue to much of Russia's policy.

Mr. Wight points out that profound as is the common material interest in the planned development of the economics of geographical areas and groups of nations, it does not touch the problem of power. Every Power has an interest greater than welfare, an interest on which it believes that welfare depends and to which welfare must in the last resort be sacrificed—the maintenance of power itself. Nevertheless, the idea of a common moral obligation is probably a more fruitful social doctrine than the idea of a common material interest, and if the greater realism which characterizes the mood of 1946 as against the mood of 1918 means not the abandonment of high ideals but the discarding of foolish expectations and above all of appeasement, the traditions of Europe may not be destined to be put aside.

In this sense the position taken up by men of science generally since the existence of the atomic bomb was first made known to the world has been consistently realistic. They have never wavered from the position that the advent of atomic energy, apart from any other potential methods of scientific warfare, has made some surrender of national sovereignty the condition of the survival of civilization. They have emphasized, too, that the lines of advance to secure the restoration and reconstruction of much of the cultural life and values of the Western world are exactly those upon which scientific advance itself depends. As Prof. Farrington Daniels has pointed out, the withholding of knowledge handicaps scientific workers even within a single country or field, and, while engendering ill-will, is ineffective except for a brief period. Restoration of full freedom of investigation and of communication, except in a very limited and highly technical field of actual production of weapons of war, is an indispensable condition if creative thought is to be stimulated and the interest and keenness of men of science in the work maintained in the way that will ensure the fullest use of their abilities.

Freedom, in the fullest sense of freedom of exchange of ideas and discussion, the abrogation so far as possible of all controls and restrictions, freedom from pressure, from fear and from want, the provision of the proper atmosphere for intellectual activity is the first and most essential requirement for science, as Dr. L. A. DuBridge pointed out in a speech "Science and National Policy" to the Sigma Xi Society, and without it all is lost. Dr. DuBridge follows this plea for free exchange of scientific information and its corollary that our national programme, and the organisations adopted to execute it, must ensure the maintenance of the freedom of science, with a further plea that science is not a national but an international problem and that science should point the way to world co-operation. He is as emphatic as Prof. Daniels that the fundamental problem is international control and the organisation of the world to prevent war. If the human race is to survive war cannot continue.

The world-wide freedom for the human mind claimed in these addresses involves equally, as Dr. C. E. Merriam has pointed out in an address, "Physics and Politics", to the American Political Science Association on March 29, an analysis of the ways and means of preserving freedom and the consent of the governed in the new age opening before us. The public need of our time is the reconciliation of order with freedom, of planning and personal initiative, and it is exemplified equally in this question of freedom of scientific investigation and communication whether in nuclear energy or in other fields of science, and at the political level in the general relations between Soviet Russia and the United States and Western Europe. At both levels we may have, indeed, to evolve new forms of organisations and even new institutions to serve the needs and purposes of the post-war world.

Deliberate and serious planning through as serious an effort as in war to apply atomic and related energies to peace-time purposes, to increase the gains of civilization while guaranteeing to all men a fai share of these gains, the analysis of the organisatio of a world community and a world government and mapping the roads leading thereto—these are projects for systematic study in an era of closer unior of physics and politics submitted by Dr. Merriam and the crisis over the future of Germany, the termination of U.N.R.R.A., and the development of the Food and Agriculture Organisation are sufficient illustration of their soundness. We may not yet know the institutional forms, whether on the national or the international scale, which will best serve our purposes; but in the evolution of these forms we shall need not merely the research activities envisaged by Dr. Merriam but also every bit of help that such institutions as the universities or the religious bodies can give. That help will be required both in the study and thought leading to the evolution of new institutions or the modification of old ones and the educatior of public opinion as to need for change and th functions and meaning of the new institutions, but even more will be necessary on the spiritual and ethical plane.

The need to draw on the full intellectual, mor and spiritual resources of Western civilization mu be remembered above all on the political plane wh we approach that problem of the reconciliation freedom and discipline which lies at the root of t difficulties between Soviet Russia and the Unite States of America and Great Britain. If order ar discipline are regarded by the U.S.S.R. as their pri ary need and they are disposed in the search f security to sacrifice human personality and freedor it is right that every effort should be made to reassu them, to eliminate any substantial foundations for fear that the United Nations Organisation or any other international instrument may be directed against ther It is equally imperative that in doing so, in formulating our plans for any international organisation or supernational authority, there should be no surrender of those moral and spiritual values of Western civiliza tion in which the human spirit has found its highes expression and in which alone the conditions of scientific advance and creative achievement are satisfied. The way to understanding and reconcilia tion of the Western democracies with the U.S.S.R and with it the solution of the problem of the control of atomic energy will not be found b appeasement, but only when the concepts and the spirit of human rights and human freedom ar accepted and cultivated.

No one nation or group of nations can prescrib the methods or even provide the means by whi any other nation can realize and maintain its own spiritual ideals; but without co-operation those ideal may be unattainable, and without mutual respe and good faith they can scarcely be maintained. Th inadequacy and bankruptcy of brute force and i inability to satisfy even the material needs of man kind is increasingly apparent to-day, and the heal of the nations and the solution of those diffic problems of the control of atomic energy, the rel and rehabilitation of Europe and the Far East, t raising of standards of health and nutrition, will come nearer as the nations recognize the need for a moral and spiritual basis for the task of reconstruction and co-operation. Some spokesmen of science such as Sir Henry Dale and Prof. Niels Bohr have already rendered great service by their witness to the importance to the preservation of civilization, and with it of scientific effort, of re-establishing the common traditions and ideals of intellectual and spiritual life, including the fullest freedom of intellectual intercourse. They have set an example which statesmen will do well to note, and if the U.S.S.R. or other Powers reject the traditions of civilization and refuse to make the essential surrender of national sovereignty, the way forward does not lie in the surrender by other nations of those traditions and ideals. A better course is to shape national policy and practice upon such ideals and conditions and to build up as far as possible among the nations who share them the organisation and institutions which will serve their common purposes. So far from being directed against those who remain outside, such action will ultimately win the confidence and co-operation of those nations by the way in which such institutions minister to the needs of mankind, encourage the development and equitable distribution of resources and eliminate those disparities which have so often been the root cause of misunderstanding, ill-will and open conflict. If even Britain and the United States, for example, joined with other Powers holding similar ideals, put into practice the safeguards and inspection system recommended by the Lilienthal Commission and demonstrated the feasibility of the sacrifice of national sovereignty therein involved, something well worth while might be achieved which might prove a stepping-stone to a true super-national authority. But any such experiment demands the real and sustained interest of ordinary men and women who fully apprehend the nature of the moral and spiritual struggle involved, not simply for their own physical survival or material comfort but also for the preservation of the great intellectual, cultural and spiritual heritage of civilization.

THE EXPLANTED CELL

Biology of Tissue Cells

Essays. By Albert Fischer. Pp. ix+348+21 plates. (Copenhagen: Gyldendalske Boghandel, Nordisk Forlag; Cambridge: At the University Press; New York: G. E. Stechert and Co., 1946.) 31*s*. 6*d*. net.

TISSUE culture, it has been said, is a technique that has had a brilliant future. The criticism thus implied is one which Dr. Fischer refers to several times in his new volume of essays, and he does his utmost to refute it. But the result of the following imaginary experiment with biological history will make it clear that there is some good ground for our disappointment. Suppose that tissue cultivation had not proved workable, or that every record of its prosecution were to be wholly expunged from the literature. Would biology be so very much the worse off? It is difficult to say 'yes', at least if we exclude from formal tissue culture the embryologist's use of explantation methods to study the organised growth of large tissue fragments over relatively short periods.

The great theoretical achievements of tissue culture were mostly the work of its first ten or fifteen years. Tissue culture made it possible to prove that the cell-lineages of the ordinary somatic cells of the body are indefinite or indeterminate; to put it in the usual loose way, that somatic cells are potentially 'immortal'. More recently it has been shown that the cell types of explanted tissues are cytogenetically fixed: they breed true to histological type, and their de-differentiation is superficial and, under the appropriate conditions, reversible. Again, tissue culture has proved a theorem of real importance for the theory of development, namely, that the rate of growth and state of differentiation of cells vary inversely with one another. No experiments have made this clearer than Fischer's own. Third, it has given evidence of the universal and spectacular *mobility* of cells. Fischer says that biologists have been slow to appreciate the significance of this mobility, which he associates with Vogt's famous demonstration of the movements of cellular sheets in the process of gastrulation. Fischer himself believes that the cells of the intact organism are sessile, and remain so until a commodity which he calls 'life space' is made available to them *in vitro*. Some modern histologists, however, are prepared to believe that the majority of cells and cell processes in the organism are mobile, and that they undergo a sort of slow jostling movement in which the 'life-space' made available to any one moving cell may be that left vacant by another.

A modern view of tissue culture is that it is a technique of distinct but subordinate value which is capable of giving decisive and formally beautiful answers to problems of a rather narrow range. (One calls to mind, for example, the elegant demonstration by Landsteiner and Parker that rabbit cells continue to manufacture compounds serologically specific to the rabbit even after weeks of cultivation in media taken from the hen; and there are equally good examples from the more recent literature.) But only a small proportion of tissue culture work has been of this type. Much of it is cultivation for its own sweet sake, for as Fischer says, the beauty of cultivated tissues has beguiled many research workers into work of the narrowest general significance—to be likened, perhaps, to that of histologists who are for ever inventing new multi-coloured stains. Perhaps (is this heresy?) the formal insistence on the use of 'permanent strains' has something to do with the failure of tissue culture to pull its weight. There are radical and important differences between cultures freshly explanted from embryos of different ages; but as cultivation proceeds, the cells either come to acquire a dull uniformity of behaviour, or a diversity which bears no relationship to the age of the embryo from which they came. Meanwhile, their metabolism changes profoundly. Cultivated cells seem to bear the same relationship to their counterparts *in vivo* as does monastic life to the hurly-burly of everyday affairs—and not merely because monks, like cultures, live in cells.

Another misfortune of tissue culture is that the demand it makes on the practitioner's time and work is very often out of proportion to the value of the results to be achieved. One of Fischer's anecdotes tells how for years he renounced a holiday, in order to maintain and propagate his cultivated strains.

Tissue culture is evidently a jealous mistress. Is it very unkind to suggest she is now a little past her prime?

Fischer's book does not claim to be a treatise, and it has not the fullness of documentation of a review. It is to be regarded as a series of essays by one of the great masters of tissue-culture technique on the problems most relevant to general biology. Fischer describes the sigmoid growth-curve of the culture, its limiting size, shape-regulation, and power of true reconstitutive regeneration. In these respects it reproduces the properties of the intact organism in miniature and accessible form, for a culture is indeed an organism, and no mere assemblage of individual cells All biologists should read Chapters 3, 4, 6, 7 and 8, in which the relevance of tissue culture to general biology is made admirably clear. The later chapters are of more technical interest: one gives 'stop-press news' about the nature of 'embryo-extract'. The translation, by a Danish colleague, is grammatical but not always idiomatic.

P. B. MEDAWAR

RURAL LIFE IN JAPAN

A Japanese Village: Suye Mura

By John F. Embree. (International Library of Sociology and Social Reconstruction.) Pp. xx+268+32 plates. (London: Kegan Paul and Co., Ltd., 1946.) 18*s*. net.

SOCIAL anthropology seems at present to be entering a state of transition from the study of purely primitive societies to that of the extremely complex societies which make up the civilized world. The technique developed in the study of primitives will clearly need modification if it is to serve the study of civilized communities.

Dr. Embree's "Japanese Village" is an excellent example of the way in which social anthropology is developing to-day. The author has selected a village to suit his purpose, a village that is small enough for him to deal with the whole population, ordinary enough not to differ in any striking particular from the general run of villages, a rice-growing village neither very rich nor very poor. This he has studied in detail. After briefly sketching in the general historical background, the author describes in the three succeeding chapters the organisation and population of the village as a co-operative agricultural unit; the individual household with its relationships, its daily life and its festivities; the various forms of co-operative activity undertaken by the village in routine, such as road-making, bridge-building or house-building, in emergency, in co-operative credit societies, or on the more social occasions of festivals and gift exchanges. These chapters are followed by three more dealing with social classes and associations, social sanctions and avoidances, with the life-history of the individual, and with religion and superstition, including a calendar of monthly observances. The last chapter deals with observable change at present taking place. Appendixes are added on the economic basis of village life, and on household expenses, and specimens of talks and lectures given at village meetings are included. There are a bibliography and index and sixteen pages of good photographs, while the text contains the necessary figures and maps.

It will be seen that the life of an inhabitant of Suye Mura is described in most of its aspects; but particular emphasis is laid on the interaction betw the individual components of society and their pl in the structure of the social and territorial grou Much of the material dealt with is more complica than most rural communities might be expected show, an instance being that of the *kō* or co-operativ credit clubs which combine the function of a co operative credit bank with that of a lottery. Thi is no more a feature of a primitive society tha Japanese painting or ceramics, and the descriptio of this village community throws a fresh light o Japanese culture. A contrast to it is to be found i the religious observances of the village, the mos important part of which seems to consist in a seric of ritual observances closely bound up with th phases of the moon, and likewise in the seasona occupations of the life of an agricultural village.

The author's general method of approach, whic is in the most modern style of social anthropology recalls a remark of Disraeli's somewhere to the effec that ultimately "it is private life that governs the world".

J. H. HUTTON

GAME ANIMALS OF BRITAIN

British Game

By Brian Vesey-Fitzgerald. (The New Naturalis Series.) Pp. xv+240+72 plates. (London an Glasgow: Wm. Collins, Sons and Co., Ltd., 1946. 16*s*. net.

IN this latest volume of the "New Naturalist' series, Mr. Vesey-Fitzgerald sets forth to tell th general reader about the mammals and birds of th British Isles that are commonly called 'game'. Th book is produced in the same handsome style as it predecessors and is illustrated by a number of excel lent photographs, also by colour reproductions of ol sporting prints, etc. The author's remarks on th history of game preservation in Britain are inter esting. First he points out the probability that th Romans reared pheasants in England; but he als tells us that he cannot find any reference to a game keeper earlier than 1814, little more than one hundre and thirty years ago. As a fact, game preservatio in the sense of the protection of pheasants, partridg and grouse for sporting purposes is a comparativel recent development in the life of the well-to-d countryman. Game preservation as regards th King's deer and so on was, on the contrary, much t the fore in the Middle Ages, when game laws an penalties were stringent. Game in some sense o other has long been an important factor in th country life of the British Isles.

The author is not content to deal merely with the game birds, those mentioned above and the capercaille, black grouse, ptarmigan, red-legged partridge and quail, but writes entertainingly of wildfowl, that is, swans, geese and ducks, of the waders, including woodcock and snipe. Part 4 deals with "ground game and various", and part 5 with our three species of deer, while part 6 is devoted to the preservation of game. Among the illustrations to the ground game section is a photograph by Mr. G. B. Keary of a mountain hare in its form in the snow, which is a really remarkable snapshot.

It is somewhat ironical that an animal which provides perhaps more sport than any other British creature, namely, the fox, is always classed as vermi

, therefore in this book is only mentioned in that ...gory, apropos of which the reviewer was sur- ...d to find a remark about foxes killing weakly ...p. That hill foxes commonly take the small ...bs of mountain sheep is well known, as it is that ...o lowland foxes will very occasionally lift a weakly ...r dead lamb; but that foxes often tackle sheep, even ...eakly ones, is definitely another matter. The ...eviewer, with more than forty years experience of ...e deeds and misdeeds of foxes, has never come ...ross a case.

The chapter on the enemies of game, which treats ...f the birds and mammals that are adversaries, also ...any that are quite harmless, such as the barn owl, ...ontains much that is useful; but the chapter ...evoted to the preservation of game is the one that ...rovides most food for thought. Its remarks on the ...hanged and changing balance of Nature, on the ...ffect of shooting, plus game preservation, on British ...wild life, together with comments on the 'bird ...rank', the collector, the scientific ornithologist, etc., ...nd the controversies that have arisen between them, ...re well worth reading and much to be commended, ...s are the author's liberal views on the preservation ...f the rarer predators.

F. PITT

ELECTRIC POWER SYSTEM CONTROL

...lectric Power System Control

...y H. P. Young. (Monographs on Electrical Engin- ...eering, Vol. 11.) Second edition, revised and enlarged. Pp. xii+369. (London: Chapman and Hall, Ltd., 1946.) 25s. net.

A HOUSEHOLD electricity supply installation exemplifies in the simplest form and on a ...mall scale the power systems, the control of ...hich is described in the book under review. In ...he case of the household model in Britain there is ...sually only one source of supply. Its capacity is of ...he order of 5 kilowatts at 230 volts. It is subdivided ...t a distribution box from which circuits of about ...1 kW. capacity radiate to the different parts of the ...remises and supply lights, radiators, cookers, power ...lugs and the like. Each circuit is controlled by a ...imple hand-operated switch, and provision in the ...orm of fuses is made for automatically disconnecting ...ircuits which become faulty. All apparatus and ...wiring is well protected against mechanical damage ...so that faults are infrequent.

In the power systems which supply domestic and industrial consumers, the distribution is at 400/230 volts and each distribution circuit is of about 200 kW. Supplying the distribution system, there is a net- work of higher voltage cables working at, say, 11,000 volts, each capable of carrying about 4,000 kW. The 11,000 volt systems are in turn supplied by 33,000 volt or 66,000 volt systems, with proportionally higher power-carrying capacities.

All these systems are interconnected by the Grid, which operates at 132,000 volts and which has standard circuits of 90,000 kW. capacity.

The Grid and the correlated systems already men- tioned are subjected to hazards from lightning, air- craft, accidents and tempests. It is not economically practicable to preclude the occurrence of faults arising from such causes, so that efficient means for disconnecting faulty sections must be provided. The circuit-breakers and associated relaying systems for the Grid must disconnect almost instantly faults which may reach magnitudes of the order of 2,000,000 kW. During the War, faults of maximum severity occurred very frequently, and the almost perfect continuity of electricity supply during that abnormal period provided final evidence of the value of an interconnected power system to Britain.

In peace, the main objects of power systems are to secure maximum overall economy of production and the best practicable degree of continuity of supply.

It is now well known that the Grid has made an important contribution to the national welfare by reducing the average fuel consumption per kilowatt hour generated by some 15 per cent compared with pre-Grid generation by smaller power systems working independently.

An extremely satisfactory standard of reliability of service has likewise been attained.

The book under review draws largely from Grid practice. It provides technical information regarding the equipment which is used to control individual components in generating stations and interconnected working of power systems. It also provides a clear picture of the underlying principles of parallel operation.

Circuit-breakers, which are probably the most important component in the control of a power system, are admirably dealt with, and the latest forms of oil and air-blast types are adequately described.

Apparatus and methods for control and regulation of voltage, frequency and power flow also receive sufficient attention to satisfy the needs of users of electrical power plant. All of the foregoing com- ponents have been evolving for almost fifty years, and they are approaching stability of form and principle. There are, however, items of control equipment which have only been brought into being since the Grid was started in 1927. These are instru- ments and relays for indicating in a central control room electrical measurements such as power flows. These remote indications, as they are termed in electricity supply circles, are transmitted over tele- communication channels or actual power lines by high-frequency carrier currents. The same principles as are used for indications can be applied to remote control of plant and equipment, and the present trend is towards such control.

Mr. Young gives a good exposition of remote control and indication as at present used on the Grid system. It is probable that there will be great and even revolutionary developments in this branch of power system control, when the possibilities of apparatus used for war purposes become more widely appreciated.

A comprehensive bibliography is provided which will help those desirous of exploring the subject more completely. The diagrams and illustrations, although rather lacking in character, are adequate for their purpose.

The first edition of the book appeared in 1942 and the second in 1946. As only a few thousand people are intimately interested in power system control, this constitutes an excellent testimony to the value of Mr. Young's book. The reviewer considers that the book is an excellent basic treatise on a subject of growing importance, and hopes that further editions will appear as and when technical developments justify them.

C. W. MARSHALL

ROCKET DEVELOPMENT

By Dr. W. H. WHEELER
Deputy Director of Guided Projectiles, Ministry of Supply

Scope of Rocket Development

ROCKETS were developed and produced on a considerable scale as weapons and thrust units by all four major contestants in the Second World War. There has been since 1940, as there still is, official interchange of information between the Americans and ourselves, and a good deal is known about German developments. Comparatively little has been published by the Russians, but they are familiar with the German work and it may be assumed that they are active in the rocket field.

Pre-war developments. It is as well to admit that in rocket technique the Germans were considerably ahead of all competitors. The reason is simple; namely, they started soonest and applied most effort. So early as 1933 the rocket experimental station in Berlin was a well-established concern, developing a rocket stabilized by one large gyro in the nose; and in 1934, the gyro having now been shifted to the centre, the rocket was successfully launched on a flight of 2,000 metres. By 1938, a projectile similar in shape to the V.2 and about 25 ft. long, with automatic steering and rudders in the gas stream, was launched vertically in the manner eventually adopted for V.2. This projectile had a range of some 18 km.

As a measure of German official interest, the experimental station at Peenemünde, constructed in 1937 and 1938, cost (according to the Germans) 300,000,000 Reichmarks; and it has been stated that a prototype V.2 was the first rocket to be tested at Peenemünde, which indicates the advanced stage reached at this time.

It is of interest to note that so early as 1935, the factory equipment firm of Wilhelm Schmidding of Köln-Niehl had been in touch with Dr. von Braun at Peenemünde and devoted a section of its research department to the development of assisted take-off units and rocket propulsion units. Schmidding's firm was a typical non-armament organisation; no doubt the German armament manufacturers were already considerably implicated.

The scope of contemporary British development may be assessed from the fact that until early 1939, when the 3-in. rocket trials took place in Jamaica, no occasion had arisen justifying a large-scale ballistic trial of any British rocket. In the United States still less official interest was shown in modern rocket development until 1940, when Sir Henry Tizard took there full details of British progress and plans. This in spite of the fact that Goddard and Hickman, at the Smithsonian Institution and elsewhere, had made and fired a number of solid fuel rockets for the U.S. Army about 1919, and later forestalled, in principle at any rate, much of the technique embodied in the German V.2.

War developments. In Germany, during the War, many of the best-known armament and engineering firms were heavily involved in rocket development, and Peenemünde retained direct control of only the liquid-oxygen types. Dr. H. Walter, director of the Walterwerke at Kiel, was given responsibility for the development of hydrogen peroxide motors. Drs. Pietzsch and Adolph at the Elektro-Chemische Werke at Munich, and later at Bad Lauterberg, develo processes and laid down exceedingly large-scale pla for manufacture of concentrated hydrogen peroxid The Bayerische Motoren Werke were responsible f the development of nitric acid rocket motor uni Krupps, Rheinmetal Borsig, Dynamit A.G. and ma other concerns developed solid fuel rockets, includi a multi-stage rocket by Rheinmetal Borsig with a anticipated range of 100 miles; and the Schmiddi concern was involved in the development of rock motors using methyl nitrate and methyl alcoho ('Myrol') as propellant.

In the United States also, particularly towards th end of the War and afterwards, comprehensive development contracts were placed with industrial undertakings (many of which are still current) aimed at the development of long-range and anti-aircraft guided rockets.

In Great Britain the majority of rocket development has been carried on by the Government, started in 1936 and controlled since then by Sir Alwyn Crow in the Ministry of Supply. Some academic anc industrial institutions have collaborated, it is true notably R. P. Fraser at the Imperial College (Science and Technology and I. Lubbock at th Asiatic Petroleum Company, but the total number extramural research workers regularly employed h scarcely ever exceeded twenty. In all cases, moreov those collaborators have tackled self-contained secti of the work. One result is that only a few people Great Britain are familiar with all aspects of roc work, while others are aware only of specific applic tions upon which, for one reason or another, they hav been enlightened. In this there seems a danger th both the essential virtues and the inherent deficienc of rocket motors may be imperfectly discerned by t scientific and engineering community as a whole, and British rocket technique may never receive the impetus which derives from informed, widespread discussion and thought.

Technical Progress

It is impossible to overlook the importance of t German V.2 as a landmark in rocket developme So late as 1944 there was a very strong body technical opinion in Britain, and in the United State convinced that rockets with ranges of the order 100–200 miles were impracticable. It was admitte that these ranges might be attained by the employ ment of multi-stage rockets; but the added complexi introduced by the staging was held to preclude t employment of such rockets as practical weapon The missile which landed in Sweden on June 13, 194 provided the first irrefutable evidence that long range rockets existed, and V.2 rocket component recovered from German trials near Blizna in Poland a few months after this date (and very shortly afterwards in Great Britain!) furnished detail establishing the single-stage nature of the rocket Following, as it did, immediately after an unsatisfying period of somewhat hazardous conjecture, the rapidl accumulated mass of technical detail concerning a re long-range rocket served to fix and crystalli technical thought. Where previously every argum had been diffuse and unconvincing, due to lack experimental support, it now became possible catalogue the essential practical requirements in lo range rockets and define present and future p ities with some conviction. Most important there was tangible evidence, for all to see, of p already made, and indicative of the potentialities latent in rocket technique.

But this phase introduced a danger, aggravated by restricted knowledge, that the virtues and potentialities of more conventional rocket weapons might be forgotten; and there is still real need for the exercise of an informed analytical approach in assessing the weight and disposition of technical effort to be directed into the various channels of rocket research and development.

In spite of its great complexity in detail, even the V.2 is simple enough in conception, and it would be a tenable conclusion, after consideration of present-day rocket technique, that no revolutionary or fundamental discoveries have been made during the last ten years. It can be argued that the rocket, externally a simple example of the principle of conservation of linear momentum, and internally an embodiment of the principle of conservation of energy, offers comparatively little scope for fundamental discovery. Support is claimed for this argument in the fact that advances during recent years have been made rather in the better understanding of functional details and the application of improved materials in more effective compromise, than in rocket fundamentals.

Two different views are expressed, arising out of these considerations: one, that the time has come to place the development of rockets in the hands of engineers, the function of scientific research being to furnish, on demand, data ancillary to design; the other, that for several years the development of improved rockets must await the fruit of scientific research programmes designed to replenish the worked-out store of basic knowledge upon which the engineers must draw. The weakness of these views lies in the tacit acceptance, in both, that scientific research and engineering design applied to rockets must be treated as separate arts. To a greater extent, possibly, than any other development at the present time, rockets depend on the concerted efforts of men of science, designers and production engineers. Their closest possible integration, much more than a clear differentiation between the responsibilities of the various professional groups, should be the starting assumption.

This is the lesson to be learned from our own experience since 1939 when projectile development was constituted a self-contained establishment; from the German system, employing self-contained teams in industry; and from the Americans, who have followed suit and announced their rejection of the proposal to separate propellant research from complete motor development. Indeed, the American Service staffs have, in several instances, placed requirements *as a whole* with firms and academic institutions. Examples are Johns Hopkins University; California Institute of Technology; Sperry Gyroscope Co.; General Electric Co.; Aerojet Corporation.

Rocket Characteristics

General considerations. The outstanding common characteristic of rocket motors*, whether for projectiles or power units, is the development of thrust for limited time with minimum mechanical complexity and weight. According to the thrust required and its purpose, and the period of its application, the emphasis is between constructional simplicity and minimum weight, qualified by reliability and suitability for production and service. The broad considerations, therefore, which eventually govern the choice of a rocket motor system are as follows: (i) thrust; (ii) duration; (iii) weight; (iv) shape; (v) complexity; (vi) reliability; (vii) suitability for production.

In rocket projectiles, but not in thrust units, ballistic accuracy is often an overriding consideration.

Rocket velocity. In a non-resisting medium, and disregarding for the moment the gravity component, the velocity attained by a rocket at the end of burning is governed by (*a*) the proportionate weight of propellant in the rocket, and (*b*) the efflux velocity of the propellant gases. The relationship can be written:

$$V_r = V_g \log_e \frac{W + w}{w} = V_g \log_e \left(1 + \frac{W}{w}\right),$$

where the suffixes *r* and *g* denote 'rocket' and 'gas' velocities respectively, and W and w are the propellant weight and empty weight respectively of the rocket.

It is often convenient to have an approximate ready reckoner for rocket velocities, and by taking the first two terms of the expansion for $\log(1 + x)$ and taking 6,000 ft. per sec. as a good working value of V_g we get:

$$V_r = 6{,}000 \frac{W}{w + W/2}$$

as an approximate but useful formula for all-burnt velocity in rockets where the time of burning is not too long.

Performance index. Reference is frequently made to 'performance index' in rocket motors. It is the same thing as 'specific thrust'—pounds thrust per pound of propellant burned per second—and is directly related to efflux velocity by the momentum equation, so that

$$\text{Performance index } (I) = \frac{V_g}{g}.$$

Proportionate weight of propellant. It has also become customary in many quarters to use the ratio of propellant weight to total weight of a rocket as a criterion, and the ratio is generally written as α,

$$\text{that is, } \alpha = \frac{W}{w + W}.$$

Using these terms, the 'all-burnt' velocity of a rocket *in vacuo* becomes

$$V_r = I\, g \log_e \left(\frac{1}{1 - \alpha}\right),$$

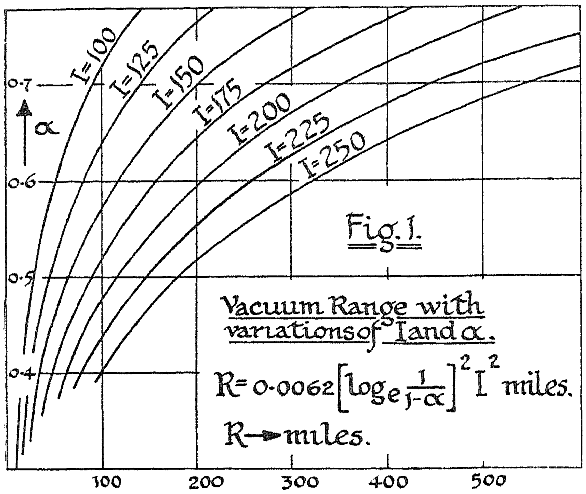
and the vacuum range at 45° becomes

$$R = \frac{V_r^2}{g} = g \left[\log_e \left(\frac{1}{1 - \alpha}\right)\right]^2 I^2.$$

Fig. 1 shows how maximum range varies with I and α, and it is useful in showing the relative effectiveness of improvement in I and α in arriving at increased range for rockets with comparable ballistic coefficient.

One of the most important characteristics of the German V.2 rocket was the high value of α achieved. For an all-up weight of 12½ tons, the rocket carried some eight tons of propellant, representing an overall value of α of 0·64, which is significantly higher than had been believed practicable in preliminary calculations made in Britain. By this means the Germans were able to content themselves with a reasonably low performance index, thereby reducing the problem of sustaining the combustion chamber against excessive heat and pressure.

* 'Rocket motor' is the name adopted to denote the rocket-thrust body without warhead or luggage.



Internal Ballistics

Broadly speaking, the difficulties of achieving high performance in rocket motors are the same for projectiles as for thrust units; the aim is always to reduce to a minimum the weight of metal components comprising fuel containers, nozzle, combustion chamber and ancillary gear, and to secure at the same time the maximum gas velocity. In projectiles, accuracy of flight imposes special difficulties. Unfortunately, high efflux velocity of propellant gases is almost synonymous with high combustion temperature and pressure, both of which tend to require heavy metal components; and in all cases, therefore, it is necessary to seek a compromise which must satisfy the broad practical considerations listed above.

Under ideal conditions where heat and friction losses are neglected, gases are assumed perfect, and all expansion is adiabatic, the equation for the jet velocity can be derived by integrating the following equation from the pressure and temperature in the combustion chamber to the pressure at the nozzle exit:

$$- v\,dp = \frac{V\,dV}{g},$$

where v is volume, p is pressure, V is gas velocity, and g is acceleration due to gravity.

The result can be expressed in the form

$$\text{Efflux velocity, } V_e = \sqrt{2gRT_c\left(\frac{\gamma}{\gamma - 1}\right)\left(1 - \frac{T_e}{T_c}\right)}$$

or, performance index,

$$I = k\,\sqrt{\frac{T_c}{M}}\left\{\frac{2\gamma}{\gamma - 1}\left[1 - \left(\frac{p_e}{p_c}\right)^{\frac{\gamma-1}{\gamma}}\right]\right\}^{\frac{1}{2}},$$

where the suffixes e and c refer to exit and chamber conditions respectively, M is the molecular weight of the gases, R is the gas constant and γ is the ratio of specific heats.

This relation shows that the performance index increases with the expansion ratio p_c/p_e; that is, with an increasing chamber pressure and decreasing exit pressure; and also with increasing combustion temperature and decreasing molecular weight. However, Fig. 2 shows that increasing chamber pressure produces only a diminishing return in performance index, and in practice it is seldom profitable, on performance grounds, to employ pressures much above 500 lb. per sq. in. Higher pressures are sometimes used to procure faster or more stable burning of propellants.

For the usual rocket motor combustion chamber and nozzle design, and the usual fuel systems, the term involving the expansion ratio and the ratio of the specific heats can be taken as roughly constant at about 0·5. The influential factor, therefore, in determining the performance index is T_c/M, and it is noteworthy that the maximum value of I does not necessarily occur at the maximum value of T_c. With systems employed at the present time the molecular weight of the exhaust gases for most fuels is between 20 and 25, except in systems containing large quantities of hydrogen of which part remains unburnt in the jet gases. On the face of it, there is scope for improvement in I by reduction in M, but this improvement is not realizable unless means can be found for increasing the hydrogen content in practical rocket motor fuels.

It is of great practical interest to observe the variations in T_c and in T_c/M as the proportion of combustible to oxidant is varied in a rocket motor system. If T_c is plotted against the percentage of combustible, it rises steadily to a maximum at the stoichiometric mixture and then falls again quite steeply (Fig. 3).

On the other hand, M will usually be falling steadily over the whole range and consequently the curve for T_c/M will have the form indicated in Fig. 4. It is immediately evident that if it is necessary to reduce the combustion temperature (c. 3,500° C. for a stoichiometric ethyl alcohol/oxygen mixture) to safeguard the combustion chamber, performance will be impaired much less by dilution on the fuel-rich side than on the oxygen-rich side of the stoichiometric mixture.

Some Constructional Problems

Solid-fuel motors. Turning now to the factors governing the ratio of propellant weight to total rocket weight, it is apparent from Fig. 1 that, theoretically at any rate and actually in practice also, there is much to be gained in ballistic performance if the propellant weight/total weight ratio, α, can be significantly increased. The problems here are mainly those of materials and design. Up to the present time, all solid fuel rocket weapons which have seen Service use have employed steel as the main material

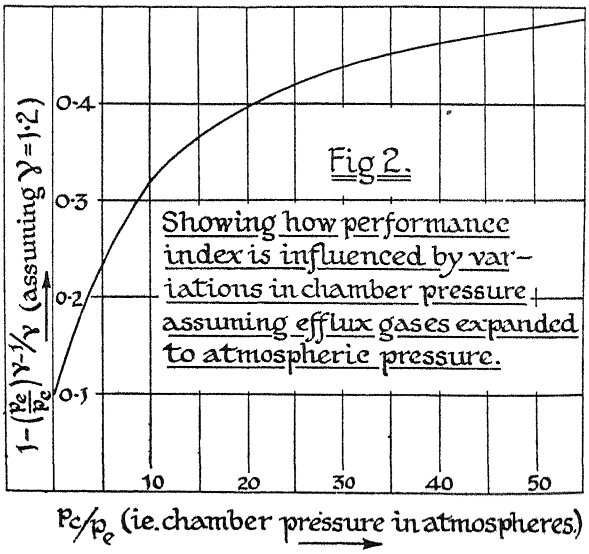


Fig 3.

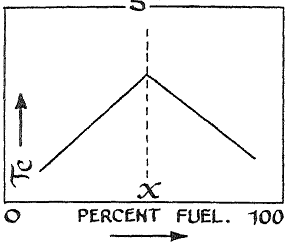
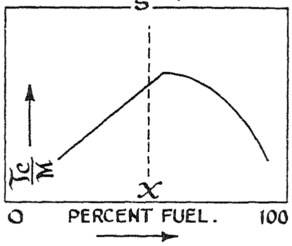


Fig 4.



of construction. The virtues of light alloys and plastics have long been recognized, and sporadic attempts have been made to utilize them; but the exigencies of the War prevented until recently any determined attack on the special problems associated with the use of these materials in rocket motors. The adoption of multi-stage rocket designs is another approach to the problem, and it is obviously possible to combine both techniques. But there are many incidental difficulties, particularly those arising from the broad practical considerations listed earlier.

When development of cordite rockets started in Great Britain, it was anticipated that the thin-walled steel tube containing the propellant would not survive the burning period of $1\frac{1}{2}$–2 sec. if cordite gases (at some 2,500° C.) were allowed in contact with the bare tube. The charge design adopted, therefore, was one in which burning took place only on the inner surface, which was star-shaped so that as burning progressed and the star section deteriorated into a circle an approximately constant burning surface was retained. The outer surface of the charge was protected by a thin layer of plastic material intended to prevent any burning on the outer surface. In this way the propellant itself was used as thermal insulation, protecting the thin steel tube. Unfortunately, the plastic material developed for the purpose proved unsuitable in certain respects and the design was abandoned. It was replaced by a simple tubular charge design in which no attempt was made to restrict the burning surface; constancy being secured by the fact that the outer surface decreased as the inner surface increased. Surprisingly, as it seemed at the time, the steel survived the burning period. Heating was minimized just sufficiently for practical purposes by reducing the outer diameter of the charge somewhat, and providing a thin layer of refractory material on the inner surface of the tube, or by using a thicker steel tube. Although the ultimate temperature attained by the steel was often as high as 700° C., at which temperature the tensile strength was too low to withstand the burning pressure, the tubes survived because heat conduction through the walls was slower than the rate of heat input. Thus, at the instant when burning ceased and the internal pressure disappeared, a relatively cool and therefore strong outer skin of steel still existed. Only several seconds later was the mean temperature attained throughout.

While this arrangement served a good purpose during the War in avoiding the development of technique for controlling surface-burning of the cordite, it could not be employed in rockets with light-alloy tubes where the strength has practically disappeared at 400° C. One of the present problems, therefore, in the reduction of empty weight, is to perfect means for burning the propellant on its inner surface only. The problem may be tackled in two ways: by the application of suitable non-combustible material on the outside of solid or tubular charges; or by pressing or casting the propellant into the tube so that it adheres sufficiently to prevent burning on the interface. For the latter system cordite is unsuitable, and mouldable, putty-like or thermoplastic propellants are envisaged.

Rocket motors will undoubtedly appear in the fairly near future in which light-alloy tubes and coated or plastic charges are employed. It is a reasonable assumption that solid-fuel rockets utilizing this technique will attain a charge/weight ratio (for the motor, exclusive of payload) of 0·6 or even higher, compared with 0·4 as the best figure attained with existing designs. This represents a velocity increase of more than 50 per cent for a rocket with 25 per cent pay-load, and an increase in maximum range of more than 100 per cent.

It may be appropriate here to insert an example of the advantage obtainable by using multi-stage rockets. The object is to reduce the wastage of propellant energy absorbed in accelerating the dead weight of fuel containers, which perform no useful function at the target end.

Ideally, the emptied portions of fuel containers would be discarded as fast as the fuel was consumed, but this is obviously not practicable. Instead of this, discrete units are discarded immediately they have completed their function. In practice, owing to the reduction in benefit for each additional stage and the increasing structural complication, the number of stages which can be employed is small.

A single-stage rocket of 100 lb. all-up weight, with a pay-load of 25 lb. and a motor containing 40 per cent by weight of propellant, would achieve an 'all-burnt' velocity of about 2,100 ft. per sec. For the same all-up weight and pay-load, a rocket comprising a first-stage motor of 50 lb. and a second-stage motor of 25 lb. would achieve an 'all-burnt' velocity of 2,650 ft. per second. The first motor, discarded on completion of burning, would produce a velocity of 1,300–1,350 ft. per sec.; the second motor would increase the velocity by the same amount.

Liquid-fuel motors. A method of improving the ratio of propellant weight to total weight which is particularly applicable to liquid-fuel rockets is to extend the time of burning. The main items of weight in the rocket motor are the combustion chamber and nozzle, the fuel expulsion gear, the fuel tanks and structure supporting them, and the fuel itself. If the time of burning is increased while the thrust remains constant, the fuel must be increased accordingly and the tanks and supporting structure with it, but the other main items of weight will remain sensibly constant. It is clear, therefore, that by this means the ratio of propellant weight to total weight (α) will steadily increase, although at a declining rate as the period of burning is extended.

There is, however, a limit to the time of burning in projectiles above which overall performance declines. This will be clear on general grounds from consideration of a rocket in which the weight of fuel is increased to the point where the projectile weight is greater than the thrust. Assuming vertical launch, in such a case, burning would proceed uselessly until sufficient fuel had been consumed to reduce the weight to a figure lower than the thrust. The useful limit for projectiles is actually reached at a point much lower than this, and it is unlikely to be profitable to increase the rocket weight much beyond half the thrust.

With the relatively short times of burning commonly employed in rocket motors used for projectiles, the survival of metal components is attributable largely to their heat capacity. By the use of massive nozzles it is possible to extend the period before failure, and for small thrusts of the order of 50–100 lb. this is generally satisfactory. But as the size of nozzle increases the practicable burning period diminishes, and for larger venturis liquid-cooling of the walls becomes imperative if a high performance index is desired. It is not practicable as yet to use liquid oxygen as coolant, and there are obvious risks with self-contained propellants of the 'Myrol' type where combustible and oxidant are already in close molecular association, but ethyl alcohol, nitric acid and hydrogen peroxide have been used successfully. In all cases where liquid cooling is employed, venturi construction is necessarily more complicated.

Accuracy

It is generally accepted that uncontrolled rockets are relatively inaccurate as weapons. Up to the present time this is, indeed, generally true; but it is wrong to conclude that rockets are necessarily and inherently grossly inaccurate weapons. The position is that the factors governing the ballistic accuracy of rockets are by no means fully understood. None the less, where accuracy is of such outstanding importance that other conflicting requirements, mainly relating to performance, can be sacrificed, a good standard of accuracy can already be attained. It is quite reasonable to assume that this standard will gradually be extended to unguided rockets of high performance.

At the present time an angular dispersion of less than 0·4° (linear mean deviation) for a rocket of high performance, fired from a stationary projector of convenient length, would be commendable. For rockets launched from aircraft the intrinsic rocket dispersion is at present about half this figure, but in this case the situation is complicated by difficulties of sighting associated with curvature of the rocket trajectory, and by sensitiveness to flight direction relative to the aircraft.

Rockets designed for special purposes have attained dispersion figures of less than 0·1° mean deviation, and while this is still about five times greater than the corresponding figure for line (as distinct from range) dispersion with guns, it could reasonably be taken as the criterion of accuracy for high-performance rockets of the future. However, this very substantial improvement will not easily be obtained with rockets of the highest capabilities, the essential lightness of construction of which is prejudicial to rigidity.

As a point of general interest, tables are included to indicate 50 per cent zones for hypothetical rockets with the improved accuracy assumed above.

TABLE 1

Total weight (lb.)	Pay-load (lb.)	Maximum range (yd)	Linear 50 per cent zones at maximum range	
			Line (yd)	Range (yd.)
60	30	17,000	80	170
160	75	24,000	120	240
300	100	40,000	190	380

TABLE 2

Total weight (lb.)	Pay-load (lb)	Maximum velocity (ft/sec)	Diameter of 50 per cent circle at 500 yd (ft.)
45	20	2,600	8
80	40	2,600	8

One of the most important objectives of future development will be the improvement of rocket accuracy, and it is clear that this would be helped considerably by a theory capable of accounting quantitatively for the existing dispersion. Early theories assume that dispersion of finned rockets can be attributed to three causes:

(a) Malalignment of the venturi on the mass centre of the rocket. The malalignment produces an upsetting couple about the mass centre and causes the rocket to deviate from its theoretical trajectory.

(b) Malalignment of the fins.

(c) Unpredictable meteorological conditions, such as wind gusts.

Lack of rigidity in the projector and loss of propellant during burning are other contributory causes, but they are usually treated separately. For experimental purposes, complete rigidity of the projector can easily be ensured and the loss in range attributable to loss of propellant can be estimated from the reduction in velocity at the end of burning.

Of the three causes listed above, the first is predominant and the one around which most interest centres. The simple approach is the assumption that the axis of the resultant thrust on the rocket coincides with the geometrical axis of the emergent cone of the venturi. The malalignment can be measured for rounds before they are fired, and from these data the dispersion expected from this cause can be calculated. Trials have shown, however, that there is no clear-cut correlation, either in magnitude or in direction, between the deviations observed in firings and those estimated on the basis of this assumption.

It is an obvious criticism of the simple assumption made above that the malalignment measured on an unfired round may not be significant because the line of the jet may not coincide with the axis of the emergent cone; and the hot propellant gases and sudden onset of pressure may shift or distort the venturi or alter the curvature of the rocket tube. Moreover, the head of the rocket is often attached to the motor tube in such a way that it might be temporarily displaced by pressure in the tube.

The experimental technique needed to elucidate the actual mechanism and intrinsic significance of these various occurrences is quite difficult and progress is being made rather slowly. The result is that it is not yet known precisely at what points extreme accuracy of manufacture and the greatest possible rigidity and freedom from distortion should be insisted upon, nor where manufacturing relaxations can be permitted with impunity.

It might be hoped that the difficulties encountered with finned rockets could be evaded by the adoption of gyroscopic stabilization. It would be expected that errors contributory to dispersion would be smoothed out by rotation about the rocket axis. To some extent this is certainly true, and rotated rockets have provided some good dispersion figures, but the disconcerting feature is that the disparity between calculated and actual dispersions for rotated rockets is of the same order as for fin-stabilized rockets. It is from the elucidation of this 'unknown factor' in rocket dispersion that major progress in accuracy may be derived.

Conclusion

In conclusion, it may be observed that after sporadic development through several centuries and quite intensive development during the last ten years, rockets have reached a stage where they can be considered a reliable mechanism. As heat engines they are necessarily inefficient, and there is little prospect of eliminating completely the supply and storage considerations peculiar to rocket propellants. None the less, rocket motors perform certain functions more efficiently and economically than any other power unit. Wherever power is required for relatively short periods, for the minimum of transported weight, rocket motors will compete ; and in the absence of air the technique of rocket combustion may offer the only feasible system of propulsion. Used as projectiles, the peculiar advantages of absence of recoil and comparatively low set-back inherent in rockets have already given rise to remarkable weapon applications. Of these, on the British side, probably the most outstanding were the aircraft rocket enabling a single-seat fighter to deliver a salvo equal in hitting power to the broadside from a small cruiser ; the 'rocket ships', each capable of disgorging highly lethal ammunition on the chosen target area at the rate of half a ton a second, for nearly a minute ; and the 'land mattress' (so called because it was a 'softening' weapon), in which a battery of 12–30 barrel mountings concentrated, under one command, medium artillery fire power comparable with the normal complement of a whole Army Group.

This article has been written by Dr. W. H. Wheeler, a member of the staff of the Ministry of Supply associated with the British development work described. Thanks are due to the Director General of Scientific Research (Defence) for arranging for the preparation of the article and for permission to publish the information.

TROPIC-PROOFING OF OPTICAL INSTRUMENTS BY A FUNGICIDE

By Prof. J. S TURNER, Associate Prof. E. I. McLENNAN, Dr. J. S. ROGERS and E. MATTHAEI
University of Melbourne

IT is remarkable that the problem of the deterioration of optical instruments by fungi has remained so long without thorough investigation. Until 1939 very few people seem to have realized that fungi can grow actively on or over the internal optics of binoculars, cameras, etc., exposed to warm and humid conditions. The trouble became acute, however, in Australia when military units went into action in New Guinea.

Not only were the facilities for storage of instruments extremely primitive in the early stages of this campaign[1], but, as has since been shown, parts of New Guinea are climatically the worst possible places for fungal troubles. In a short time, the fungal infection of instruments designed for temperate regions became a major problem. Optical instrument workshops, adequately equipped and staffed for normal repair work, found themselves entirely unable to cope with the flood of fungus-infected instruments which descended upon them. Many types of instruments lasted only for four to eight weeks before infection ; and, very often, new instruments awaiting issue in depots were found to be deteriorating rapidly on the shelves because of fungal attack. In fact, instruments in store were affected more than those

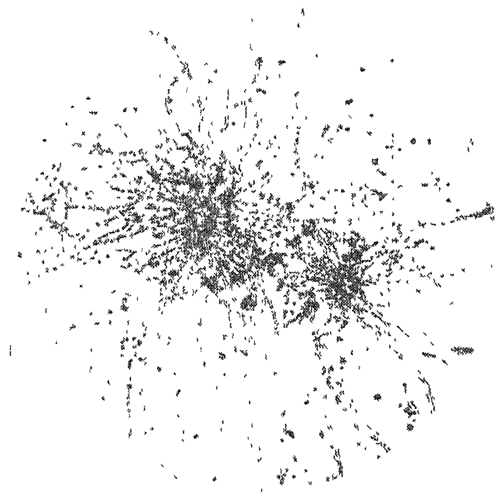


Fig. 1 *Penicillium* sporulating colony on binocular prism from New Guinea × 50

in use, and the trouble was greatest where they were housed in leather cases and stored in wooden boxes.

Accordingly, in 1943, the Australian Scientific Instrument and Optical Panel (an advisory panel to the Ordnance Production Directorate of the Ministry of Munitions, Australia) set up a special subcommittee, which carried out research on this problem and which has issued interim reports from October 29, 1943, up to the present time[2]. Considerable research was carried out during the same period in both the United States[3] and Great Britain[4]. In this report we shall summarize the results of the Australian work, which led to a reasonably effective method of tropic-proofing optical instruments.

The fungi which grow in optical instruments belong to the groups Phycomycetes, Ascomycetes and Fungi Imperfecti. The following species were frequently isolated from instruments which had been in New Guinea : *Penicillium spinulosum*, Thom., *P. commune*, Thom., *P. citrinum*, Thom., *Aspergillus niger*, Van Tiegh., *Trichoderma viride*, Pers. ex-Fr., *Mucor racemosus*, Fres., and *M. ramannianus*, A. Moeller. So far, *Monilia crassa* has not been isolated from Australian instruments, although Dr. W. G. Hutchinson[5], of the United States, found this to be a common species in the Panama zone, and it has also been recorded as frequent in West Africa by Major I. G. Campbell[6].

The fungal spores germinate on the moist surface of the glass lenses or prisms or, more frequently, on particles of dust, luting wax, cork and other organic debris. The mycelium spreads thence over the whole surface of the clean optical glass (Fig. 1). The moulds are particularly troublesome when they grow on graticules, but they are also capable of obscuring lenses and prisms. The fine hyphal threads in contact with the glass surfaces are often surrounded by minute condensed water droplets (Fig. 2) or by droplets of alkali-soluble substances liberated from the glass itself. If the mycelium remains for many months in contact with the glass, it is capable of etching a pattern into it. More commonly, when removed, the mycelium leaves only a slight stain (Fig. 3) resembling an oil film which can be removed by cerium oxide polishing.

The committee concentrated at first on methods for tropic-proofing the many thousands of impressed

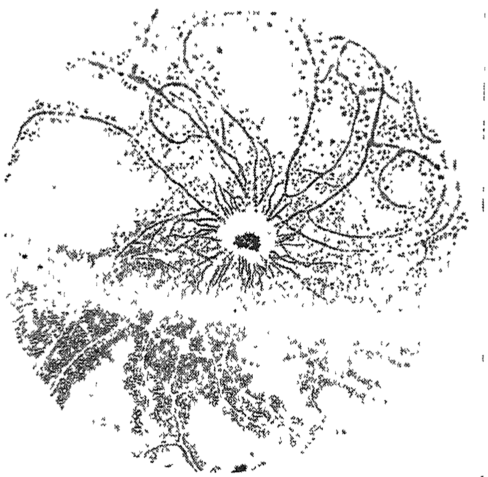


FIG. 2. SURFACE VIEW OF LENS FROM RANGE-FINDER. IN CENTRE IS A PARTICLE OF ORGANIC DEBRIS FROM WHICH THE MYCELIUM OF *Penicillium* HAS RADIATED. THE HALO OF LIQUID DROPLETS WHICH SURROUND EACH HYPHA IS CLEARLY VISIBLE. × 50

civilian binoculars which were to be issued to the Australian Services. It was early decided that it would be futile to attempt to desiccate these instruments or to ensure that they were optically clean and sterile when dispatched. A search was made, therefore, for a suitable volatile fungicide which could be placed in the instrument during its first reservicing and fitting with graticules. The requirements of the fungicide were: (*a*) toxicity to all possible contaminants, (*b*) action at a distance (that is, volatility) for the substance could not be placed directly on the optics, (*c*) stability in moist air and to a temperature of at least 60° C., (*d*) persistence of action over some months or, preferably, years, (*e*) lack of power to corrode metals, especially brass, steel, and aluminium alloys, (*f*) non-toxicity to man, (*g*) mite repellent (because mites have been shown to enter optical instruments carrying fungal spores with them), (*h*) availability in war-time.

As might be expected, very few of the known fungicides passed even the first of these tests. The initial laboratory experiment was designed to select a fungicide with the properties noted in (*a*) and (*b*) above. For this purpose the substance under test was incorporated in luting wax and a drop of this was melted on to a microscope slide. This was then inverted and a hanging-drop culture of mixed spores from optical instruments was set up around the wax.

The following known fungicides were shown to be ineffective under these conditions for some or all of the moulds concerned: 'Ceresan', 'Agrosan', 'Shirlan', 8-hydroxy-quinoline, penta-brom-phenol, tetramethyl thiuram disulphide, tri-brom-phenol, azo-chloranide, clove oil, copper naphthenate, phenyl mercuric acetate, tri-oxy-methylene, methyl alcohol and thymol. Many other fungicides were not tested here, following adverse reports on their properties from other workers, for example, naphthalene, paraformaldehyde. Thymol was the most promising, but further experiments with it were discontinued when it was found that an organic mercurial completely suppressed the germination of all the species with which we were concerned. This substance was sodium ethylmercurithiosalicylate, referred to here as 'M.T.S.'. It had been produced in Australia on a large laboratory scale by Prof. V. M. Trikojus and his associates of the Universities of Sydney and later of Melbourne. It was in use by the Australian Army Medical Corps for the preservation of blood. Prof. Trikojus suggested its trial for tropic proofing, and very extensive tests have shown it to be the best fungicide so far investigated by us for this particular purpose.

At first, the M.T.S. was incorporated only into luting waxes, but later it was mixed with a black lacquer, which was used to cover the interior metal surfaces of optical instruments. It was mixed with this paint to give a concentration of 0·2 per cent in the liquid and it was also incorporated in the microcrystalline wax which we used for luting purposes. Our experiments show that the dry M.T.S., pure, or in paint, is scarcely volatile at all, but in the presence of water vapour it is decomposed, probably by hydrolysis, to give a very active fungicidal and fungistatic vapour.

Following hanging-drop tests, binoculars and range-finders were painted internally with the poisoned lacquer and mixed fungal spores were dusted on thin agar films with which the optics had been coated. The instruments were then assembled in the normal way and placed in a tropic-proofing test cabinet under conditions of high humidities and temperatures. Some of the instruments were also wrapped in damp calico which had been sprinkled with spores, and living mites were introduced into the cabinets. Under these conditions, no fungal growth occurred inside the treated instruments, but there was abundant growth in the control instruments which had not been poisoned. In later experiments, cylindrical tins of 300 $cm.^3$ capacity were painted internally with black lacquer, some of which had been poisoned with M.T.S. or with its butyl or methyl esters, in concentrations of 0·2 per cent. The space inside was saturated with water vapour, and each tin contained, for the actual test, a microscope slide covered with a film of nutrient agar and dusted with fungal spores. In no instances have spores germinated in tins containing the M.T.S.-poisoned paint, although some of these tests were carried out six months after the paint had been applied to tins open to the atmosphere through

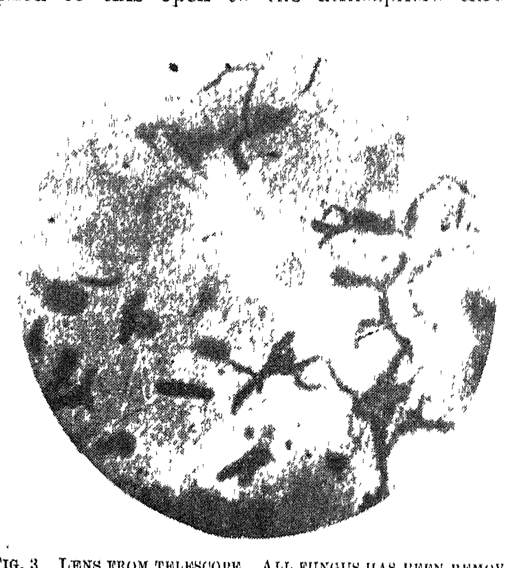


FIG. 3. LENS FROM TELESCOPE. ALL FUNGUS HAS BEEN REMOVED BY OPTICAL CLEANING, BUT THE 'OIL STAIN' IS STILL VISIBLE UNDER SUITABLE ILLUMINATION. × 30

minute holes. The vapour arising from the M.T.S. paint has been shown to kill the spores as well as to inhibit their growth. Further experiments, carried out by an officer of the Victorian Department of Agriculture, have shown that the vapour arising from the hydrolysis of M.T.S. is lethal to mites, but it does not act as a mite repellent. This corresponds with our own experience; and we have found that, while mites entering M.T.S.-treated instruments are killed, their bodies do not then act as centres for the growth of fungi.

In the experiments with closed tins referred to above, some germination of spores did take place when the paint contained either the butyl or the methyl ester of M.T.S., but only when the tins had previously been stored for six months. The methyl ester was the less promising, but Dr. Hutchinson, of the United States, has informed us that the butyl ester which we supplied to him was rather more effective than M.T.S. itself in his Panama Zone experiments. This ester has the advantage of being soluble in lipoid solvents, and further trial may prove it to be a fungicide of better value than the sodium salt (M.T.S.) itself.

Once the value of M.T.S. as a fungicide was established, it became necessary to test its corrosive power. The first results were most discouraging, as it was found that aqueous solutions of M.T.S., both in the acid form and as the sodium, copper and zinc salts, brought about rapid accelerated corrosion of aluminium and some slight corrosion of brass. The corrosion was of a type which suggested that free mercury ions were released in solution and catalysed the reaction. However, it has since been found that when incorporated in a suitable lacquer, the M.T.S. causes no corrosion at all of the metal under the lacquer or of unpainted damp metal surfaces near by, even when the test piece is enclosed in a small volume of warm, damp air. On the contrary, the layer of lacquer protects the metal surfaces against the action of water vapour, which is known to cause extensive corrosion in optical instruments exposed to tropical conditions. So far as experiments have gone, there is no evidence that M.T.S. attacks lens cements (balsam or *n*-butyl methacrylate), nor does it cause the filming of optics.

This lack of corrosion by M.T.S. in paint may have been due in part to the special properties of the paint we employed. We have recommended the use of a nitro-cellulose lacquer which dries quickly to a reasonably matt surface. It is manufactured by B.A.L.M. under the name of 'Duco Enamel Lacquer'. Recent reports from England indicate that other lacquers are not necessarily suitable. We have also found it not advisable, from the point of view of corrosion, to incorporate the M.T.S. into the zinc oxide-retinax grease used as a lubricant for eyepiece threads. It should be noted here that the M.T.S. makes up 0·2 per cent of the liquid lacquer; when this dries out, the mercurial poison is dispersed in the film at a concentration approaching 0·8 per cent.

Our corrosion tests are supplemented by observations on binoculars which have been tropic-proofed with M.T.S. and exposed for long periods as follows: (1) some instruments were kept for three months in the laboratory in Melbourne; (2) others were exposed for two months in a test chamber to 100 per cent relative humidity and 30° C.; (3) about thirty instruments were exposed to tropical conditions in New Guinea for two and a half months and then returned to Melbourne for examination.

Corrosion in all these instruments was limited to that taking place on exposed aluminium alloy surfaces and its extent was that which would be expected, from control experiments, to occur whether M.T.S. was present or not. Experiments at the Munitions Supply Laboratories, Maribyrnong, have also shown that black lacquer containing 0·2 per cent M.T.S. does not cause 'season cracking' of brass. Finally, although many thousands of optical instruments have now been tropic-proofed in the way recommended, there has been no report from the Services of corrosion in these instruments.

These tests and observations have convinced us that there is very little danger of corrosion by M.T.S. in paint. They have, at the same time, led us to recommend that all internal metallic surfaces of optical instruments for tropic use should be painted or anodized so as to render corrosion by *water vapour* negligible.

Since 1943, numerous field experiments in New Guinea have confirmed the value of M.T.S. as a fungicide in optical munitions. A short test in 1944 with thirty-four binoculars in stores at Milne Bay, Lae and Port Moresby was inconclusive in that many of the control instruments did not become infected. However, at Lae, four binoculars containing M.T.S. remained free from infection on all optics, while two untreated instruments were all infected on various optical surfaces

Later, twenty binoculars and six range-finders were exposed in Kunai grass near the jungle for six months and then returned to Melbourne for examination. One side of each of the binoculars was tropic-treated, while the other side acted as control. Three range-finders were treated and three acted as control. After six months, there was no infection in any of the treated sides of the binoculars, except for one slight trace of non-sporing fungus on one prism. Practically all the untreated sides were infected, some badly. All three treated range-finders were free of fungus, while all the untreated instruments were badly infected. This is a striking proof of the efficacy of M.T.S., as the range-finders are badly sealed instruments and yet even in these the fungicide retained its activity.

A long-term experiment has just been started in New Britain. One hundred instruments (binoculars) have been assembled with exactly the same luting, lacquer and eyepiece grease; but on one side of each instrument the lacquer and luting contain M.T.S., while the other side is free of this substance. Twenty-five pairs are to be returned to Melbourne at six-month intervals for examination. The efficacy of the fungicide will thus be tested over a period of two years.

Three pairs of binoculars treated with M.T.S. in Melbourne have been exposed to tropical conditions in the Panama zone. They are still under test, but they have so far remained free of fungus for a period of five months.

Perhaps the most striking evidence in favour of M.T.S. is its control of fungal infection in aircraft cameras, which are, of course, badly sealed instruments. At the beginning of 1944, the secretary of the Scientific Instrument and Optical Panel was approached by an officer of a camera repair unit of the U.S.A.A.F., who reported very severe damage to aircraft cameras caused by fungi. The unit adopted the M.T.S. treatment for all its cameras and has reported that none of the 350 cameras so treated became infected during a period when approximately a hundred lenses, including fifty from aircraft cameras, were returned for the removal of fungi from the optics One aircraft camera, treated with M.T.S, has remained internally free of fungus for a period of twelve months, although, on occasion, fungi have had to be wiped off the external lens faces. Officers of this unit have also found that the growth of fungus in fibre cases for carrying cameras could be prevented by coating the cases internally with black lacquer containing M.T.S.

The Australian Military Forces adopted the M.T.S. treatment in 1944, and all types of optical instruments manufactured or assembled in Australia, including thousands of binoculars, have been treated in this way. The R.A.A.F. and one section of the U.S A.A.F have also adopted the method, as has the Royal Australian Navy. Recent reports from Britain indicate that the method is undergoing tests by the R.A.F., although it is there recommended that internal metal surfaces should be anodized or covered with a primer before the poison lacquer is applied.

In aqueous solution M.T.S. will prevent the growth of *Penicillium* at concentrations so low as 1 in 2 millions. It is used locally in 1 in 1,000 solution, as a tincture for skin disinfection and as a nasal spray, and it has also proved of value for preserving blood serum[7]. It is regarded as most unlikely to cause any harm to man in the concentrations recommended for tropic proofing, as the lethal dose for man is believed to be about 1,000 milligrams. Its action at a distance is best shown as follows. Black paint containing 0·2 per cent M.T.S. is used to coat glass plates approximately 4 in. square; the painted surface is then apposed to a similar plate coated with thin agar dusted richly with *Penicillium* spores. The two plates are kept 2 mm. apart by spacing strips round the edges. No spores germinate (in fact they are killed) on the agar when the two plates are incubated under humid conditions. If, however, the paint is applied in two narrow bands forming a cross, spores do germinate to form a thin mycelium, but only in the corners of the plate. The mycelium then slowly spreads towards the middle where the concentration of toxic vapour is at the maximum. Under these conditions it appears that mutual reaction between the fungus and the vapour keeps the concentration down and allows slowly continued growth of mycelium. The vapour (which presumably contains a mercury compound) takes effect whether the paint lies above or below the agar; but in some experiments it was noticed that the inhibition of growth on plates held vertical was exerted over a greater distance on the lower sides of horizontal painted bands.

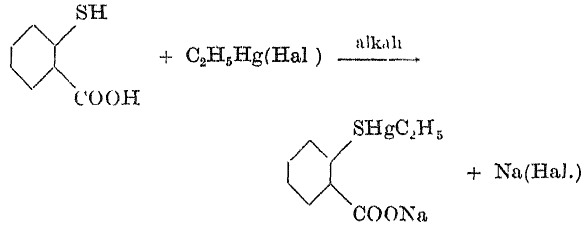
Incorporated into paints, M.T.S. may prove to be a useful fungicide apart from its application to optical munitions. For example, Mr. P. G. Law has suggested its use as a preventive of mould spotting in framed prints. Preliminary tests indicate that, if the wooden back of a picture frame is painted with M.T.S. lacquer on the side facing the print, mould growth in humid atmospheres is prevented. Technical officers in museums and galleries may find that further investigation along these lines is worth while.

The authors desire to acknowledge the valuable assistance of the other members of the Scientific Instrument and Optical Panel committee: Mr. P. G. Law, Mr. J. W. Blamey, of the University of Melbourne; Mr. G. C. Wade, of the Victorian Department of Agriculture. Our thanks are also due to Prof. V. M. Trikojus, Mr. G. M. Willis of the Metallurgical Department, University of Melbourne, Mr. M. Pack of B.A.L.M and several officers of the Munitions Supply Laboratories, who all made contributions towards the solution of the problem. The Tropical Scientific Section of the Scientific Liaison Bureau, Melbourne, rendered assistance in the carrying out of the field tests in New Guinea.

CHEMISTRY OF SODIUM ETHYLMERCURITHIOSALICYLATE

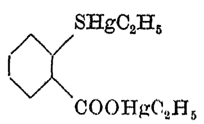
By Prof. V. M TRIKOJUS
University of Melbourne

SODIUM ethylmercurithiosalicylate (I) is a white crystalline solid, melting at about 230° C. and easily soluble in water and the lower alcohols, but insoluble in lipoid solvents. Its preparation was first reported by Kharasch in 1928[8], who used the following reaction (cf. also Waldo[9]):

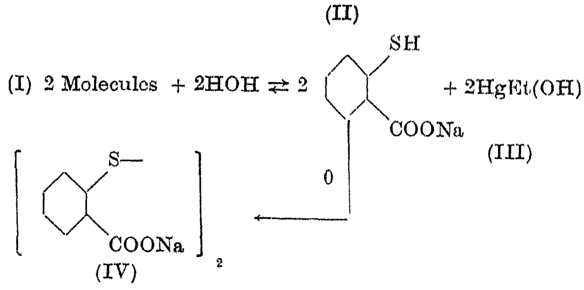


(I)

In the manufacture of the drug in Australia for plasma preservation and tropic-proofing, undertaken initially by J. E. Falk and since, in larger quantities, by R. H. Hackman, ethylmercuribromide was condensed with thiosalicylic acid (15 per cent excess) in aqueous-ethanol with the equivalent of 2·5 mol. sodium hydroxide. About a kilogram of thiosalicylic acid was used per batch. The crude ethylmercurithiosalicylic acid (by precipitation with hydrochloric acid) was purified by recrystallizing the sodium bicarbonate-soluble, acetic acid-precipitable fraction from 50, 75 and finally 98 per cent ethanol. The yield was up to 80 per cent of colourless crystals, m.p. 112°. One criterion of purity was that the sodium salt should give a clear 10 per cent aqueous solution. An unexpected impurity, isolated in small quantity, is probably di(ethylmercuri)thiosalicylate (II, colourless leaflets, m p. 157°; Hg: found, 65 5 per cent; calc. ($C_{11}H_{14}O_2SHg_2$), 65·6 per cent).



(II)



Methyl-(ethylmercuri)-thiosalicylate (colourless solid, m.p. 40/41°; Hg: found, 50·5 per cent; calc. ($C_{10}H_{12}O_2SHg$), 50·55 per cent) and the corresponding *n*-butyl derivative (pale liquid; Hg· found, 44·9 per cent; calc. ($C_{13}H_{18}O_3SHg$), 45·7 per cent) were obtained in practically quantitative yields from ethylmercuribromide, sodium hydroxide and the thiosalicylic esters. Both compounds are insoluble in water but readily soluble in lipoid solvents, an obvious advantage when applying the materials to paints and lacquers; moreover, the methyl ester can be obtained in a pure condition much more conveniently than the sodium salt.

The action mechanism of the sodium salt as a fungistatic and fungicidal agent is uncertain. It has been proved to act at a distance, but it is improbable that a sodium salt of this configuration would possess a significant vapour pressure. Kharasch has pointed out that aqueous solutions of the sodium salt tend to break down to ethylmercurihydroxide (III) and sodium thiosalicylate, the latter, in the presence of oxygen, passing irreversibly to the dithiosalicylate (IV). Thus the access of water vapour, providing conditions for fungal growth, might also favour a similar breakdown of the lacquer-incorporated mercurial, or even further to more volatile substances.

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[2] Scientific Instrument and Optical Panel, Ministry of Munitions, Australia "The Tropic Proofing of Optical Instruments, Part I", July 1944
[3] O S.R.D Reports, U S A, No 1833, July 1943, No 4188, September 1944
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[8] Kharasch, M S, U.S.P, 1, 672, 615 (1928).
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Comments by Dr. J. W. J. Fay, Ministry of Supply

I AM glad to have seen these two interesting papers, and take the opportunity of offering the following comments on British experience.

Two factors have militated against the use in Britain of M.T.S. on other than an experimental scale.

First, in the design of new instruments, or the modification of old types, the tendency has throughout been towards the improvement of sealing and of packaging. This, coupled with the use, if necessary, of a desiccating agent, is considered the ideal at which to aim, since the need of a fungicide is eliminated.

Secondly, in connexion with the protection of old instruments, including ex-civilian surrendered types of unknown history, the incorporation of volatile fungicides was not without its dangers. Thus, various substances tried gave rise to such troubles as softening of cements, corrosion and filming. Nevertheless, the need for a suitable fungicide was recognized and many were tested.

Among these, M.T.S., of which the vapour pressure is extremely low, was found to depend for its action upon a decomposition in the presence of moisture, giving rise to a volatile mercury compound which is presumably the active agent. The decomposition was found to be accompanied by a corrosion danger, and in the lacquers we have used this danger has not yet been overcome. We are, however, now awaiting samples of Australian lacquer for test.

In general, therefore, even in the case of old-type instruments, our attitude has been to improve sealing and methods of servicing, packing and storing, and the tendency is in any case to regard the incorporation of a desiccant as preferable to the use of fungicides.

With reference to the New Guinea experiments, we have had the opportunity of examining a few of the instruments tested, and our view is that while the results afford evidence of the superiority of the new *complete* Australian 'tropical treated' method over the old one, it is not entirely clear, in the absence of true controls, how much of the improvement is to be ascribed to the use of M.T.S. For this reason, we shall look forward with great interest to the results of the long-term New Britain experiments in which rigid controls are apparently included.

FIBROUS PROTEINS

BOTH the man of science and the technologist are greatly indebted to the Society of Dyers and Colourists for its enterprise in organising a symposium on fibrous proteins so soon after the end of the War. The meetings were held at the University of Leeds during May 23–25, and among the three hundred in attendance were visitors from Australia, Belgium, France, Holland, Norway, Sweden and the United States Full details of the proceedings will appear in a volume which is to be issued shortly by the Society. Some thirty papers were read and discussed · they covered subjects ranging from the structure of protein molecules to the production of synthetic protein fibres, from the thermodynamics of water adsorption by proteins to the production of an unshrinkable finish on wool. No distinction could be drawn between science and technology, for new methods of examining the structure of wool and silk were shown to give results with a profound bearing on recent hypotheses concerning the structure of protein molecules in general, and technological advances were found to be the direct outcome of a clearer understanding of the nature of the proteins.

Our present conception of the structure of protein molecules is based to a large extent on the results of X-ray analysis in the hands of Prof. W. T. Astbury and his collaborators. In their view, proteins of the keratin-myosin-epidermis-fibrinogen group are characterized by long-range elasticity and the reversible α—β intramolecular transformation. When wool fibres are steamed for two minutes at 50 per cent extension, they contract to a length 30 per cent less than the original length on release in steam. Supercontraction of this type has been referred by Astbury to more severe folding of the polypeptide chains than in the case of α-keratin. Dr. K M. Rudall pointed out at the time when this hypothesis was advanced that folding of this type should be revealed by a cross-β pattern on examination by X-ray methods. A cross-β pattern had been obtained by Astbury in work on the denaturation of egg-white in boiling water, and has since been observed in a number of other cases.

In his paper on the structure of epidermal protein, Rudall showed that a cross-β pattern could be obtained with strips of cow's lip epidermis which had been supercontracted in water at 100° C. Similar behaviour was observed with films of the protein extracted from the epidermis with 50 per cent urea. The most striking of Rudall's observations was, however, the demonstration that the cross-β pattern of supercontracted epidermis and epidermin disappeared and was replaced by a normal α-pattern when the protein was treated with 50 per cent urea. This at once prompted Rudall to examine the effect of 50 per cent urea on steam-set β-keratin. Cotswold wool stretched 70 per cent and set in boiling water for five minutes showed a complete return of the α-photograph after forty-eight hours in saturated urea. The return was less complete with fibres which had been steamed for thirty minutes at 60 per cent extension; but Rudall was led to inquire whether the setting of β-proteins is not mainly a process whereby the chains are locked by close fitting in the backbone direction. Both Prof. J. B. Speakman and Mr. H. J. Woods pointed out, however, that the set released by saturated urea was probably simply temporary set, that is, the set which disappears when the fibres are released in steam. According to Speakman, true permanent set is due to disulphide bond hydrolysis, which permits relaxation, followed by linkage rebuilding, through the combination of basic side chains with the products of hydrolysis of the disulphide linkages, which gives stability to the relaxed structure. Further support to the structure is, of course, afforded by hydrogen bonding between the main peptide chains, but true permanent set was believed to be impossible without the formation of new cross-linkages between the peptide chains.

Curiously enough, Dr. H. Phillips, in his paper on the division of the combined cystine in wool into four sub-fractions of differing chemical reactivity, was led, on different grounds, to make the same suggestion that permanent set is due to hydrogen bonding between the main chains of the relaxed fibre. Phillips's reason for making this suggestion was a doubt whether disulphide bond hydrolysis could take place in the very short time of steaming necessary to relax the extended fibre. It seemed to him much more likely that the weaker hydrogen bonds of the extended fibre are broken by the initial steaming and re-form slowly in the relaxed fibre. Against this view it was pointed out that stretched fibres could not be set by immersion in concentrated solutions of weak acids which eliminate hydrogen bonding between the main peptide chains, followed by washing and drying to permit re-formation of hydrogen bonds.

The special problems involved in the structure analysis of high polymers by X-ray methods were discussed by Dr. I. MacArthur in a paper which included an exhaustive summary of recent developments in experimental technique. Data of great value in supplementing the results of X-ray analysis are likely to be obtained by Dr. A. J. P. Martin's methods of examining partial hydrolysates of proteins. He outlined the results so far obtained in an examination of a partial hydrolysate of wool, with an average chain length of a little more than two units, by ionophoresis and partition chromatography. Up to the present, only that fraction of the hydrolysate which moves towards the anode in ionophoresis has been examined; but the results are of far-reaching importance. Seventeen dipeptides involving aspartic and glutamic acids were isolated and identified, and Martin argued that the existence of so many dipeptides is sufficient to disprove Bergmann and Niemann's view that "the radicals of each sort of amino-acid occur at regular intervals in the peptide chain . . . the intervals being of the form 2^m3^n places". Further, as regards Astbury's view that the amino-acids in the polypeptide chains of keratin are alternately polar and non-polar, he concluded that the hypothesis cannot be correct because he succeeded in isolating from the partial hydrolysate a number of polar-polar dipeptides, including aspartyl glutamic, glutamyl glutamic, seryl aspartic, seryl glutamic and tyrosyl glutamic acids

During the course of the subsequent discussion, Prof. Astbury replied that his proposal was that polar and non-polar residues *for the most part* follow one another alternately; wool is not necessarily a single protein, and room for the occurrence of polar-polar dipeptides is thus provided. Martin was, however, unable to accept even the suggestion that polar and non-polar residues follow one another alternately *for the most part* because, although he had no quantitative data, the individual dipeptide of the polar-polar type was not notably weaker than that of the polar non-polar or non-polar polar types. In fact, glutamyl glutamic acid "was one of the strongest present". Before any final conclusions can be drawn, however, data for the neutral and positive fractions of the partial hydrolysate must be obtained.

The Bergmann–Niemann hypothesis was also discussed by Dr. D. Coleman and Dr. F. O. Howitt in a paper on the structure of silk fibroin. They have found that silk can be brought into solution by means of cupri-ethylene diamine, each combined copper atom being co-ordinated with the nitrogen atoms of two adjacent amino-acid residues. When the solution is neutralized with acetic acid and dialysed until free from copper, a clear solution of fibroin is obtained. The mean molecular weight of the dissolved protein was about 30,000, but, on digestion with trypsin, a substance having a mean molecular weight of 8,000–10,000 separated out. This substance was free from proline and contained less than 1 per cent tyrosine. The Bergmann–Niemann hypothesis, however, requires that, of the 420–430 amino-acid residues in the silk molecule, the four proline and the twenty or so tyrosine residues are regularly spaced along the chain. Since the product of tryptic digestion is composed of molecules which are about one third the length of the parent molecule and contain no proline and very little tyrosine, it is obvious that the Bergmann–Niemann hypothesis is invalid for silk fibroin. All or most of the tyrosine residues and all the proline residues appear to be situated at points roughly one third and two thirds along the length of the molecule from one end.

Closely related to the work of Coleman and Howitt is that of Dr. C. S. Whewell and Mr. H. J. Woods, who found that roughly one atom of copper is associated with every two amino-acid residues when wool is treated with a solution of cuprammonium hydroxide. The wool does not, however, pass into solution, presumably because the main peptide chains are cross-linked by cystine. Instead, the fibres contract 26 per cent with progressive weakening of the α-photograph, which returns when the fibres resume their original length on removal of copper with sulphuric acid. Supercontraction appears to be due to additional folding of the main peptide chains, brought about by co-ordination of copper with neighbouring nitrogen atoms in the chains.

In the case of fibroin, solubilization by means of cupri-ethylene diamine is due to separation of chains in the β-configuration through hydrogen bond breakdown, when the nitrogen atoms of neighbouring amino-acid residues are co-ordinated with copper atoms, followed by folding of the molecules at the points rich in proline and tyrosine. In agreement with this view, films prepared from the dissolved protein were found to be capable of extension to three or four times their original length. Further, whereas the original film was water-soluble, the stretched film was insoluble in water. These observations lend considerable support to Astbury's conception of a common structural pattern for all proteins, for fibroin appears to be an ideal example of denaturation, and Coleman and Howitt have succeeded in converting it into the globular form, and from the globular form into the fibrous form. Hitherto, in fibre technology, it has merely been possible to convert globular proteins, such as casein, arachin and egg albumin, into the fibrous form.

Various aspects of the production of fibres from globular proteins were discussed by a number of speakers. The optimum conditions for extracting protein from groundnuts and soya beans were defined in a paper by Mr. R. H. K. Thomson, but fibres spun from solutions obtained under such conditions are weak and highly extensible in water, even after hardening with formaldehyde. As indicated by Dr. M. Harris and Dr. E. Brown in their comparison of natural and synthetic protein fibres, more effective cross-linking of the main peptide chains in the latter is a pressing need. The problem was discussed by Dr. F. Happey and Dr. R. L. Wormell, who showed that the strength of casein fibre could be increased by after-treatment with basic zinc chloride and formaldehyde, owing to the formation of metal-containing cross-linkages. Even then, however, the rate of dyeing of casein fibre with acid dyes is much greater than that of wool, as indicated by Mr. C. P. Tattersfield. In practice, accurate control over the degree of cross-linking of the casein is essential, and Dr. L. Maaskant, in an interesting paper, showed how the surface film technique could be used for this purpose. The orientation of macromolecules by interfaces was also discussed by Dr. D. J. Crisp.

One of the most interesting features of the symposium was the discussion on the mechanism of water adsorption by proteins. Dr. G. A. Gilbert criticized the three theories at present in use for describing the adsorption of water by textile fibres, namely, those of Peirce, Cassie, and Brunauer, Emmett and Teller. Cassie's theory is a modification of that of Brunauer, Emmett and Teller, and its nature and consequences were summarized by the author. After discussing the effect of swelling on the sorption isotherm he proceeded to derive a stress-free isotherm. From an analysis of the latter he concluded that the water-attracting groups in keratin are —CO— groups. Objection to the view that the multilayer of water is under very great pressure was taken by Gilbert, and Dr. P. H. Hermans believed that "the entire theoretical reasoning in Dr. Cassie's paper supports the solution theory". Dr. R. M. Barrer thought it doubtful whether the model on which the Brunauer, Emmett and Teller isotherm is based can be applied to compact, non-porous sorbing media such as wool, and he outlined an alternative theory based on (*a*) an initial, rather energetic, sorption of water molecules upon a finite number of localized sites obeying the Langmuir type of sorption, and (*b*) a simultaneous and independent process of sorption by mixing of water and polymer chains. Opinion seemed strongly in favour of this conception, the elaboration of which will be awaited with interest. It has an important bearing on the attempts which have been made to determine the 'free' and 'bound' water in proteins, a problem which was discussed by Dr. H. Eilers and Dr. J. W. A. Labout in connexion with hides and the processes of leather manufacture.

Turning now to technological processes, a number of papers were concerned with the dyeing of textile fibres. Dr. B. Nilssen discussed the formation of strongly coloured complexes when tyrosine-containing fibres are treated with nitrites and metallic salts. As regards the usual methods of dyeing, Dr. R. M. Barrer believed that the art has outstripped its scientific foundation, and he laid the foundation for a fundamental study of the kinetics of dyeing by deriving four differential equations to describe the non-steady state of flow. Methods of obtaining the diffusion coefficient from each of these equations were indicated, and procedures for determining the activity of the sorbed molecules were described. The application of these methods to the study of dyeing processes is likely to bring about a marked improvement in our understanding of their nature.

The combination of wool with acids and acid dyes was also discussed by Prof. J. B. Speakman and Dr. G. H. Elliott, chief attention being given to the apparent conflict between the chemical and X-ray evidence concerning the mode of combination of colour acids with wool. The nature of the conflict is best illustrated by taking the case of Coomassie Milling Scarlet *G*. The combining capacity of wool for the colour acid is the same as for hydrochloric acid, suggesting that all the free amino groups of wool are accessible to the colour acid. X-ray examination of the dyed fibres by Dr. I. MacArthur, however, revealed no distortion of the normal α-photograph, suggesting that the dye anions had not penetrated the crystalline phase, though penetration of hydrogen ions was indicated by its impaired setting properties. The authors suggested that the two sets of observations could be reconciled if hydrogen ions were to penetrate the micelles and leave an equivalent number of dye anions on their surfaces. A safeguard against the development of an excessive potential is provided by micellar subdivision and by the electron mobility of the protein molecule itself.

The properties of damaged wools were discussed by Dr. D. R. Lemin and Dr. T. Vickerstaff, normal wool being compared with chlorinated, peroxide-treated, alkali-treated and carbonized wools. After establishing the isoionic points of the wools, they determined their titration curves with hydrochloric acid and their affinities for Naphthalene Orange *G*, but the differences in affinity for the dye were small. Analysis of the hydrochloric acid titration curve led the authors to suggest the presence of two types of carboxyl group in the fibre, but objection to the mathematical treatment was made by Mr. L. Peters. As regards the combination of wool with acid and determinations of the isoelectric point, he emphasized that much confusion would be avoided if attention were given to the internal *p*H of the fibre and not, as is usual, to the *p*H of the solution with which it is in equilibrium. Using the Donnan theory of membrane equilibrium, he was able to show that a single curve will describe the titration of wool with solutions of hydrochloric acid containing sodium chloride in all concentrations up to $1{\cdot}0M$. Similarly, Dr. T. H. Morton, in a paper on the equilibrium between silk and aqueous solutions, stressed the importance of the *internal* *p*H value of silk whenever its chemical reactivity is being studied.

Considerable attention was also given to processes for making wool textile materials unshrinkable, that is, for preventing the kind of shrinkage which wool fabrics, as distinct from those composed of cotton or rayon, undergo when they are rubbed in aqueous media. Shrinkage of this kind is due primarily to the surface scale structure of wool fibres. The scales function as a ratchet and cause the fibres to migrate under pressure in the direction of their root ends, thus consolidating the structure Shrinkage can be prevented by treating the wool with gaseous chlorine or chlorine water, which leads to the formation of a gelatinous degradation product of keratin on or under the scales of the fibres According to Speakman, the essential reaction in the chlorination process is disulphide bond breakdown in the surface layers of the fibre, and it is interesting that most present-day processes, which were exhaustively reviewed by Mr. M. Freney, are based on the use of reagents such as chlorine, sulphuryl chloride and sodium hydroxide, which are known to be capable of causing disulphide bond breakdown. Further support for this view was provided by Dr. R. F. Hudson and Dr. P. Alexander, who showed that when wool is made unshrinkable with fluorine, sulphur is removed as the volatile hexafluoride. Dr. Alexander also found that wool could be made unshrinkable by treatment for only fifteen seconds in a 0·5 per cent solution of potassium permanganate in 0.5N sulphuric acid Curiously enough, the treated material shrinks on being worked in acid solution, although it is unshrinkable in soap solution, possibly because of the greater swelling of the degraded protein in alkali.

In recent years, several new methods of making wool fabrics unshrinkable have been proposed. Instead of attacking the surface scale structure of the fibres, their elastic properties are modified. One such method, which was described by Dr. J R. Dudley and Dr. J. E. Lynn, consists in impregnating the fabric with a solution of methylated methylol melamines and an acid catalyst, drying, and baking at 285° F A high degree of unshrinkability is obtained with 10 per cent of polymer within the fibres. Alternatively, the elastic properties of the fibres can be altered by increasing the number of cross-linkages between the peptide chains, and the advantage of these new processes is that the weight and wear-resistance of the fabrics are increased. Even better results, as regards wear-resistance, are obtained when anchored films of polymer are formed on the surface of the fibres, unshrinkability being obtained in this case by masking of the scales In the light of these and other developments there can be little doubt that polymerization reactions will continue to find extensive applications in the textile industries.

J. B. SPEAKMAN

NEWS and VIEWS

Imperial College of Tropical Agriculture : Mr. O. T. Faulkner, C.M.G.

MR. O. T. FAULKNER has just retired from Trinidad, where he has occupied the post of principal of the Imperial College of Tropical Agriculture since September 1938. He had only been in charge for a year when war broke out. It fell to his lot, therefore, to administer the College during a period of exceeding difficulty, and all schemes for development and progress had perforce to be kept in abeyance. That he has been able to keep the Institution alive as a going concern and in a fit state to tackle future developments is all the more to his credit. For it must be remembered that the College is perhaps unique in that its governing body, from which its policy emanates, is four thousand miles away. In peace-time, this alone presents certain problems ; but during a war, when all communications are liable to be upset and personal visits are prohibited owing to transport dislocations, the difficulties are greatly increased. On the academic side, one of the main problems was to arrange for the lecture courses, as students were liable to arrive at all sorts of times owing to shipping difficulties. Further problems arose when, after the Cambridge School of Agriculture closed early on in the War, it was decided to send the Colonial Office agricultural scholars to Trinidad for two years instead of the customary one. With no additional personnel and a depleted staff long overdue for leave in a temperate climate, it can readily be imagined that the problem was not an easy one. In spite of this, and of the difficult economic and social problems in Trinidad caused by war conditions, the new duties were cheerfully accepted.

On the research side an immense amount has been done by Faulkner and his staff in planning for the future and in continuing existing lines of work. Although the report of the 1939 Royal Commission on the West Indies was not published in full until after the War ended, its recommendations to make the College the centre of research for all the Caribbean Colonies were examined in detail in conjunction with the Comptroller of Development and Welfare and his staff. Now after long discussion, a definite plan for the development of the College with greatly increased duties on the research side and wider contacts with other scientific and academic institutions has finally been achieved, and Mr. Faulkner will be able to retire with the full knowledge and satisfaction that all his labour and careful thought during the war years will not have been in vain

Physics in the University of Dublin : Dr. E. T. S. Walton

THE appointment of Dr E. T. S Walton to the Erasmus Smith professorship of natural and experimental philosophy in the University of Dublin, in succession to Prof. R. W. Ditchburn, will be welcomed by all those who know Dr. Walton's work Dr. Walton joined the Cavendish Laboratory as a research student in 1927, after a good experimental record in classical physics at Trinity College. Rutherford suggested that he should investigate the possibility of a new method of accelerating electrons, by spinning them in the circular electric field surrounding a changing magnetic field—the method which was later to be developed into the betatron. Walton first investigated theoretically the conditions for stable orbits in the system and obtained two of the well-known betatron stability equations—the flux condition and the radial field variation condition. He built an apparatus in which the induction field was obtained by discharging a condenser through a coil wrapped round an evacuated glass tube of about

8 cm. diameter. A filament provided an electron source, and X-rays were looked for. These experiments did not succeed, but Walton's theoretical work was a guide leading to the later success of Wideroe and Kerst.

Walton built also about this time a very early model of a 'linear accelerator' It is probably still to be found among the Cavendish 'junk'. Walton then turned to work with J. D. Cockcroft, who was building an apparatus for the acceleration of positive ions. During the years 1929–32 they developed together the voltage quadrupler steady potential generator of 600 kilovolts, and the acceleration tube for protons which led to their discovery of the disintegration of the light elements by protons The nature of these disintegrations was established by Wilson chamber work carried out by P. I. Dee and Walton. For the work on disintegration of the light elements, Dr. Walton and Dr. Cockcroft were awarded jointly the Hughes Medal of the Royal Society in 1938.

Atomic Energy for Industrial Purposes

THE text of a report submitted to the United Nations Atomic Energy Commission in New York by the U.S. representative, Mr. Bernard Baruch, has been released through the U.S. Information Service. It sets out the results of a careful study of the costs of producing nuclear power by the relatively inefficient process in use at Hanford; that is, with a slow-neutron reactor, using a graphite moderator and ordinary uranium metal, modified to allow of heat extraction at a temperature where the heat-exchanging medium, gas or water, can be used efficiently in a gas or steam turbine. The report was prepared by the staff of the Clinton Laboratories (the experimental 'pile' at Oak Ridge, Tennessee), assisted by engineers of the Monsanto Chemical Co. Their conclusion is that by the use of existing techniques it should be possible to generate electric power at 0·8 cents per unit compared with 0 65 cents per unit for a coal-burning station, making the same assumptions in each case concerning amortization of capital charges and interest on capital. It is assumed with confidence that certain difficult technological problems connected with the extraction of the heat at a high temperature can be solved.

This is an important statement since it contradicts the pessimistic view about the industrial application of atomic energy which has been expressed in some influential quarters in Britain. The report emphasizes that nuclear power has many advantages over existing sources of energy for some specialized applications as, for example, where fuel or cooling water are unobtainable. It emphasizes that coal costs are tending to move upwards, while further research and development will undoubtedly make the cost of nuclear energy move downwards. These conclusions should give impetus to the development of nuclear energy for industrial purposes in Great Britain and the British Commonwealth, where conditions exist already for the rapid application of the new methods as an alternative to coal or hydro-electric power.

American Physical Society and the Freedom of Science

THE summer meeting of the American Physical Society was held in Chicago on June 20–22. It was mainly devoted to nuclear physics, and much of the work done under the Manhattan Project and only recently declassified was made public for the first time. There were ninety-seven contributed papers, the abstracts of which have since been printed in the *Physical Review* (70, 101; July 1946). In addition, there were eight invited papers. These included. "Elementary Pile Theory", by E. Fermi, "Theory of Nuclear Reactions", by G. Breit; "Physics Research and Release of Nuclear Energy", by A. H. Compton (this was delivered as an after-dinner address); "The Transuranium Elements", by G. T. Seaborg; and two papers dealing with neutrons

The following resolution was passed by the Council of the Society: "The Council of the American Physical Society, being convinced that the national welfare and even the national security depend on the progress and diffusion of scientific knowledge, go on record as affirming that the restoration of freedom of scientific research and publication as it existed before the war is an urgent national necessity. The healthy condition of our science and technology, which was such a great national asset during the war years, will be greatly impaired if the freedom of science is not restored in the immediate future".

Atomic Energy and Political Propaganda

THE pamphlet "Atomic Energy and Social Progress" issued by the Communist Party demonstrates clearly how the words of men of science may be distorted to political ends. It is difficult to believe that any scientific worker will have the patience to read the mixture of dialectics, irrelevancies, distortion and prejudice which Mr. William Paul has woven into this piece of pure propaganda masquerading under a catchword title. Its existence is not merely a warning to men of science to weigh their words, but also an illustration of the difficulty due to titles which besets the compiler of any bibliography in rejecting the chaff while retaining the grain.

Geomagnetic Disturbance of September 16–23

A WEEK of geomagnetic disturbances, culminating in a 'great storm' during September 21–22, coincided with the epoch of the autumnal equinox as well as with the passage across the sun's disk of a large group of spots during September 13–26. Spots of area 500–1,000 millionths of the sun's hemisphere are, however, now fairly frequent with the rise towards maximum of the 11-year solar cycle; but the recent group with a maximum area around 1,000 millionths represented a renewal of activity in the region of the great July sunspot (*Nature*, Aug. 3, p. 160). This recent epoch of geomagnetic disturbance opened on September 16 at 13h. 47m. U.T. with a 'sudden commencement', but the small storm which followed may be taken as having ended on the following day about 6h. Fourteen hours later a long-continued disturbance began somewhat indefinitely, and lasted until September 20, 0h The maximum ranges at Abinger during this interval of nearly three days were considerable, namely, 250 γ in horizontal force and 290 γ in vertical force, the latter range almost raising the status of the disturbance to that of a great storm. Although no specific solar flares can as yet be related to these two periods of magnetic disturbance, it should be noted that at the time of the sudden commencement on September 16, the centre of the spot group was within the central part of the sun's disk, which is effective in the known statistical relationships between the greater magnetic storms and individual large sunspots. However, storms of moderate intensity do in any event occur with markedly increased frequency at the epoch of the equinoxes even at solar minimum.

The 'great storm' which next followed was, with a high degree of probability, directly associated with one or more solar flares within this sunspot region that had shown intense activity two months earlier. The magnetic storm began on September 21 with a marked 'sudden commencement' at 17h. 13m. U.T., but activity did not become conspicuous until 04h 25m. on September 22. The most intense period was still later, between 10h and 22h Between 14h. and 15h., the movements of the traces were so rapid that ranges of 200 γ in H in one minute of time were frequent. The storm ended rather uncertainly about 8h. on September 23 The extreme ranges at Abinger (kindly communicated by the Astronomer Royal) were: 2° 16′ in declination; 925 γ in horizontal force, and 450 γ in vertical force.

A complete but short-lived radio fade-out beginning at 11h. 05m. on September 21 was reported to Greenwich by Cable and Wireless Ltd., and during this fade-out a solar flare (not of great magnitude) was partially observed at Greenwich. But the statistical average time-interval between the beginning of a great magnetic storm and its antecedent intense solar flare is 21½ hours. This interval from the 'sudden commencement' at 17h. 13m. on September 21 would place the probable flare during the Greenwich night hours. Solar observations in $H\alpha$ from America, Australia and India are required to pursue further the connexion between this storm and a specific solar outburst within the sunspot area.

Experimental Stress Analysis Group

A meeting was held at University College, London, on September 6, with the provost of the College, Dr. D. R. Pye, in the chair and some sixty persons from academic, government and industrial research establishments present to discuss the formation of a society concerning itself with photo-elasticity. It was decided to extend the scope to other techniques of experimental stress analysis, and to form an informal group the object of which will be the interchange of knowledge and experience among its members. Some of the research workers had suggested that the group should be part of the Institute of Physics rather than form a new society. The secretary of the Institute of Physics, who was present by invitation, stated that the Institute was always prepared to give sympathetic consideration to requests from informal groups interested in applied physics for a little assistance in the inaugural period, and that this could be accepted without prejudice to the ultimate decision. It was therefore agreed to leave the constitution open for the present, and in the meantime to make a formal request to the Institute for temporary assistance.

Colonel H. T. Jessop (University College, London) was elected chairman of the Group, and Mr. E. K. Frankl (Engineering Department, University of Cambridge), honorary secretary. The following were elected to the Committee: Mr. W. A. P. Fisher (R.A.E., Farnborough), Mr. R. G. Manley (Vickers Armstrong, Ltd., Newcastle-on-Tyne), Mr. C. W. Newberry (L.M.S. Railway, Research Dept., Derby), Dr. S. C. Redshaw (Boulton Paul Aircraft Co., Wolverhampton), Mr. D. G. Sopwith (Engineering Div., National Physical Laboratory, Teddington), Dr. J. Ward (Huddersfield Technical College). The Committee was instructed to: (1) widen the circle of membership by getting in touch with research workers in all fields of experimental stress analysis; (2) make arrangements for a meeting within twelve months at which papers shall be read and the future constitution of the Group shall be decided; (3) prepare and circulate bulletins of information which may be of interest to members. Any research workers or others who are interested in experimental stress analysis are invited to communicate with the honorary secretary of the Group.

Dissemination of Scientific Information

AMONG the papers presented at the Royal Society Empire Scientific Conference last July, a group dealing with the dissemination of scientific information among scientific workers do not appear to have been noticed in the scientific and technical Press, although they indicate possibilities recently discussed in these columns (see *Nature*, 157, 745; 1946). Prof. J. D. Bernal's contribution, "The Form and Distribution of Scientific Papers", briefly summarizes ideas he expressed at the Conference last year of the Association of Special Libraries and Information Bureaux, while Dr. L. M. Lampitt's paper, "An Abstracting Service", discussing the difficulty of reconciling both the informative and indicative abstract, nevertheless concludes that a central abstracting science service should be developed which should issue both types of abstract. On the council or board of this body would be representatives of all the major publishing societies and institutions. Both types of abstract should be highly sectionalized and the scheme should be financed jointly by the State, industry and the scientific worker. Dr. Lampitt's proposals thus go some way towards meeting the ideas of Prof. Bernal; Miss Ditmas' paper on "Special Libraries" also touches on the question of abstracting, but it is mainly concerned with the library system and with bibliographical services. Ideas presented in Mrs. Lucia Moholy's paper, "A Central Office of Documentary Reproduction", have already been discussed in *Nature* (157, 38; 1946), while the largest paper in this symposium, a review of information services by Prof. R. S. Hutton, supplements the other four contributions, examining the fundamental requirements of the collection and distribution of scientific and technical information, the growing difficulties which face such services, and indicating some proposals which have been made for improvement. Neither Prof. Hutton nor Miss Ditmas refers to the earlier report of the British Commonwealth Science Committee (cf. *Nature*, 152, 29; 1943), which contained a strong recommendation in favour of co-operation in abstracting services.

British Medical Students' Journal

"FOR the first time," says the editor of the first issue of this journal, "British medical students from all over the country are to produce a journal." The first plan for this journal was drawn up by A. Malone of the London Hospital and D. Whittingham of Durham, and the editorial board of three men and one woman propose to publish in the future technical articles and news, "complemented wherever possible by art and literature of a high standard". Resisting attempts to impose upon them a partisan approach to many problems, the editorial board have wisely decided to be guided only by the wishes of the majority. They will fight for international co-operation and have, for this reason, devoted the whole of this first issue to an account of the new International Students' Federation and of the re-birth of the Czech universities; for it was in Prague at the World Students' Congress in November 1945 that an important part of the work on the foundations of this new organisation was done. The first ordinary issue of the *British Medical Students' Journal* (published from B.M.A. House, Tavistock Square, London, W.C.1) is appearing in October, and thereafter one issue will be published each term, each containing essays, articles and news interesting to medical students. An indication of the kind of fare to be provided is given by the announcement in this issue that the October number will contain articles by Sir Joseph Barcroft on fœtal respiration, by Prof. Samson Wright on hypertension, by Dr. James Marshall on penicillin and venereal disease, and by Dr. Charles Hill, secretary of the British Medical Association, on the National Health Service, together with news, short stories and articles contributed from all over Britain. An interesting feature will be a section devoted to nurses who wish to improve the efficiency and conditions of their service. It is particularly gratifying to know that medical students, like so many other sections of the community, wish to help the nurses to attain the status, remuneration and conditions of life and work which are merited by the important part they play in modern medical practice.

Man's Ancestry in Africa

FURTHER details of the circumstances and character of the recently announced discovery of relics of two early forms of extinct anthropoids have now been recorded by Dr. L. S. B. Leakey (*The Times*, August 23). Two lower jaws were found within 15 ft. of one another by Dr. Leakey, while on leave from war-time duties, in the Lower Miocene deposits of Rusinga Island which lies at the mouth of Kavirondo Bay in the north-east corner of Victoria Nyanza. Of these two specimens, one has since been identified as belonging to the genus *Proconsul*, the other as belonging to the genus *Xanopithecus*. These two genera with a third, *Limnopithecus*, were first discovered and described by Dr. A. T. Hopwood in 1931 when working as a member of the "Third Leakey East African Archæological Expedition" on the Lower Miocene deposits at Koru in Kenya. Further discoveries of fossil ape material were made by Dr. Leakey and other members of his expedition at Rusinga and elsewhere between 1931 and 1935. Dr. Hopwood regarded *Proconsul* as a very close relative of the chimpanzee, and *Limnopithecus* as being of the same stock as the gibbons. When the new specimens now recorded by Dr. Leakey had been cleaned and examined it was found that the *Proconsul* jaw, which is very nearly complete and the most nearly perfect of any fossil anthropoid jaw yet discovered, did not show so close a relationship to the chimpanzees as Dr. Hopwood had thought. It was, in fact, much more human in certain characters than not only the chimpanzee jaw but also that of the Piltdown skull. The chin is more vertical, there is no simian shelf (the ledge of bone on the anterior aspect of the symphysial area of the jaws of all apes) and the condyle in many ways is more like that of a man than an ape. Of possible alternatives, Dr. Leakey favours the view that in *Proconsul* we have a near approach to an ape-like form from which the human stem eventually was evolved, and goes on to suggest that notwithstanding recent tendencies to look to Asia, Africa may well be the place of origin of man.

The Old Moon in the Arms of the New

MOHD. A. R. KHAN, of the Hyderabad Academy, Begumpet, Deccan, has a paper with this title in *Popular Astronomy* (53, No 7, August 1945) in which it is suggested that variations in the lunar earthshine may be partly due at times to intense meteoric activity on the moon. It is not necessary to suppose that the moon has an atmosphere to make this theory feasible, because bombardment of the moon's unprotected surface could explain the appearance. A profitable piece of research would be to try to correlate the luminosity of that portion of the moon visible under earthshine with meteoric displays observed on the earth. Reference is made to a paper by Walter H. Haas, "Concerning Possible Lunar Meteoric Phenomena" (*Contributions of the Society for Research on Meteorites*, 3, 98), which describes two lunar flares that he observed with his 4-in. refractor in 1938. It would be interesting to know what conclusions, if any, have been drawn from these observations.

Swelling Pressure in Gels

FOREST PRODUCTS RESEARCH SPECIAL REPORT No. 6 (London: H.M. Stationery Office. 1*s*.) deals with "Swelling Stresses in Gels, and the Calculation of the Elastic Constants of Gels from their Hygroscopic Properties". The results are of importance in the use of composite wood products or synthetic plastics derived from natural fibres, and the general aspects of the subject are also dealt with. The abstruse theory is concisely but adequately set out, and the tendency of the paper is theoretical, very little experimental material being presented.

Announcements

THE Royal Astronomical Society will celebrate the discovery of Neptune on September 23, 1846, by holding a conversazione on October 8. Prof. W. M. Smart, regius professor of astronomy in the University of Glasgow, will deliver an address on "John Couch Adams and the Discovery of Neptune", and there will be exhibits relating to Adams, Le Verrier, Tycho Brahe and John Flamsteed.

SIR JAMES CHADWICK, professor of physics in the University of Liverpool, will deliver the Melchett Lecture for 1946 of the Institute of Fuel on October 8, at 6.0 p.m., at the Central Hall, Westminster, London, S.W.1; he will speak on "Atomic Energy and its Applications".

DR. J. RAMSBOTTOM is giving lectures at the British Museum (Natural History) on edible fungi on Mondays and Wednesdays at 2.30 p.m. The lectures will be continued until October 16.

THE Committee of Privy Council for the Organisation and Development of Agricultural Research has appointed Dr. A. N. Drury, Dr. Joseph F. Duncan and Prof. T. J. Mackie to be members of the Agricultural Research Council. They succeed Prof. D. Keilin, Major James Keith and Prof. F. T. Brooks, whose terms of office have expired.

THE Committee of Privy Council for Medical Research has appointed Mr. C. A. B. Wilcock, M.P., Prof. C. A. Lovatt Evans (Jodrell professor of physiology in the University of London) and Prof. R. A. Peters (Whitley professor of biochemistry in the University of Oxford) to be members of the Medical Research Council.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Cryoscopic Proof of the Formation of Nitronium Ion

As the result of work on the optical absorption and electrical conductivity of mixtures of nitric and sulphuric acids, and on the depression of the freezing point of sulphuric acid by added nitric acid, Hantzsch concluded that in such solutions nitric acid is largely converted into two cations, $H_2NO_3{+}$ and $H_3NO_3{++}$, the latter being the principal form present in excess of sulphuric acid[1] The optical and electrical work showed essentially that the nitric acid is converted into an altered form, and that this consists of or contains ions The cryoscopic work furnished a specific argument in favour of the bivalent ion For the univalent ion corresponds to a two-fold, and the bivalent ion to a three-fold, depression by nitric acid of the freezing point of the sulphuric acid solvent the van't Hoff i-factors would be as shown Experimentally, Hantzsch found a three-fold depression ($i = 3$)

$$HNO_3 + H_2SO_4 = H_2NO_3{+} + HSO_4{-} \quad (i = 2)$$
$$HNO_3 + 2H_2SO_4 = H_3NO_3{++} + 2HSO_4{-} \quad (i = 3)$$

The remaining evidence of a specific nature consists in Hantzsch's claim to have isolated crystalline perchlorates corresponding to each of his ions, namely, the salts $(H_2NO_3{+})(ClO_4{-})$ and $(H_3NO_3{++})(ClO_4{-})_2$ (cf the following note)

The purpose of this note is to record a revision of the freezing point evidence, for when corrected it provides an unambiguous proof that the cation into which nitric acid is actually converted in sulphuric acid is neither of Hantzsch's ions, but the nitronium ion, $NO_2{+}$

Hantzsch's conclusion in favour of a three-fold depression of freezing point was later supported by Robles and Moles[2], but the methods employed were not accurate, nor were the results concordant However, the technique of cryoscopy in sulphuric acid has since been much improved by Hammett[3]; and, using essentially his methods, we have established that the depression produced by nitric acid is four-fold, that is, that each molecule of nitric acid added to the sulphuric acid solvent produces four solute particles Only one interpretation is possible, namely, that $NO_2{+}$ is formed according to the equation

$$HNO_3 + 2H_2SO_4 = NO_2{+} + H_3O{+} + 2HSO_4{-} \quad (i = 4)$$

We also find that each of the oxides of nitrogen, N_2O_5, N_2O_4 and N_2O_3, produces a six-fold depression of the freezing point of sulphuric acid The corresponding equations are

$$N_2O_5 + 3H_2SO_4 = 2NO_2{+} + H_3O{+} + 3HSO_4{-} \quad (i = 6)$$
$$N_2O_4 + 3H_2SO_4 = NO_2{+} + NO{+} + H_3O{+} + 3HSO_4{-} \quad (i = 6)$$
$$N_2O_3 + 3H_2SO_4 = 2NO{+} + H_3O{+} + 3HSO_4{-} \quad (i = 6)$$

Furthermore, Mr. D. J. Millen has confirmed the presence in the relevant solutions of all the ions represented in these equations by the method of Raman spectroscopy—excepting for $H_3O{+}$, which, as is well known, cannot be detected by this means.

Our experimental values for the i-factors of van't Hoff are as follows·

HNO_3	10 determinations	i = 3 82
N_2O_5	10 ,,	5 85
N_2O_4	6 ,,	5 84
N_2O_3	5 ,,	5 85

Hammett's results for H_2O lead to $i = 1\ 92$. The small deviations of all these figures from integral values give mean activity coefficients of 0 96 ± 0 01 for the formed binary electrolytes, $(H_3O{+})(HSO_4{-})$, $(NO_2{+})(HSO_4{-})$ and $(NO{+})(HSO_4{-})$.

R J. GILLESPIE
J GRAHAM
E. D HUGHES
C K INGOLD
E R. A. PEELING
Sir William Ramsay and Ralph Forster Laboratories,
University College, London
Sept. 2.

[1] Numerous papers (1907–32).
[2] *Anal Fis Quim*, **32**, 474 (1934).
[3] *J. Amer Chem Soc*, **55**, 1900 (1933); **59** 1708 (1937).

Isolation of Salts of the Nitronium Ion

HANTZSCH[1] has claimed to have prepared, from anhydrous nitric and perchloric acids, two nitracidium perchlorates, and to have established their compositions by analysis He represents their formation as follows

$$HNO_3 + HClO_4 = (H_2NO_3{+})(ClO_4{-})$$
$$HNO_3 + 2HClO_4 = (H_3NO_3{++})(ClO_4{-})_2.$$

He states that either salt could be obtained by using the acids in the appropriate proportions, while with intermediate proportions mixtures were produced, which by crystallizing from warm nitric acid could be converted into the pure monoperchlorate or by crystallization from warm perchloric acid could be completely transformed into the diperchlorate.

Hantzsch's experimental methods, however, were not wholly suitable for the treatment of such sensitive compounds. We have therefore repeated the work, employing a vacuum technique designed completely to exclude atmospheric moisture, and using temperatures low enough to prevent decomposition of the pure acids, with the consequent production of such contaminants as nitrosonium perchlorate, $(NO{+})(ClO_4{-})$

We find that it is readily possible to obtain a solid product of the approximate composition of $(H_3NO_3{++})(ClO_4{-})_2$, it is not even necessary that the two acids should be used in the theoretical proportions However, this product is a mixture, separable by fractional crystallization from nitromethane into two components. The less soluble has been shown to be nitronium perchlorate, $(NO_2{+})(ClO_4{-})$, the other is the salt $(H_3O{+})(ClO_4{-})$, well known as the hydrate of perchloric acid

We have not been able to prepare any dry salt, or dry mixture, of the composition of $(H_2NO_3{+})(ClO_4{-})$ However, we find that adhering nitric acid is somewhat difficult to remove from $(NO_2{+})(ClO_4{-})$ by pumping, and it is possible that Hantzsch, who dried his preparations only on porous tile, may have obtained compositions approximating to that of $(H_2NO_3{+})(ClO_4{-})$ from certain of his mixtures of $(NO_2{+})(ClO_4{-})$ and $(H_3O{+})(ClO_4{-})$ which by chance contained roughly the right amount of adhering nitric acid

The separation of $(NO_2{+})(ClO_4{-})$ from $(H_3O{+})(ClO_4{-})$ by crystallization from nitromethane is tedious, and can be avoided by decomposing the $(H_3O{+})(ClO_4{-})$ by means of N_2O_5 The reaction is conveniently conducted in nitromethane, with such concentrations that the formed $(NO_2{+})(ClO_4{-})$ crystallizes

Nitronium perchlorate has almost certainly been prepared before, Gordon and Spinks[2] having obtained a deposit of the composition $NClO_6$, which with water gave nitric and perchloric acids, by mixing gas-streams containing ozone, nitrogen dioxide and chlorine dioxide An analysis of our salt may be quoted acid equivalent, 73 0 (calc, 72 7), chlorine, 24·3 (calc, 24·4), nitrogen, 9 52 (calc., 9 63 per cent) The salt has a very low vapour pressure, scarcely fumes in air, and dissolves in water with but slight liberation of heat The constitution of the solid salt has been established by Mr D J Millen by the observation of its Raman spectrum, which consists simply of the combined known spectra of the ions $NO_2{+}$ and $ClO_4{-}$ Other physical properties of the salt are being examined, and other nitronium salts, including the bisulphate, biselenate and bipyrosulphate, are being studied.

Our failure to isolate nitracidium perchlorate, $(H_2NO_3{+})(ClO_4{-})$, is consistent with the following note, which shows that the immediate effect of adding a small amount of perchloric acid to nitric acid is to produce the $NO_2{+}$ ion Thus it appears that any ion $H_2NO_3{+}$ formed with the aid of perchloric acid is largely converted into $NO_2{+}$ in an anhydrous nitric acid medium The ion $H_2NO_3{+}$ itself is probably not detectable by the Raman effect, just as the ion $H_3O{+}$ is not detectable by this means.

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Spectroscopic Identification of the Nitronium Ion

EXTENSIVE studies of the Raman spectra of mixtures of nitric and sulphuric acids have been made by Chédin[1]. He showed that such spectra were characterized by the appearance of two prominent, polarized lines, at 1,050 and 1,400 cm^{-1}, which did not belong to the spectrum of either the nitric acid or the sulphuric acid molecule. The same two lines appeared if he added either nitrogen pentoxide or phosphorus pentoxide to pure nitric acid. He therefore assigned these lines to nitrogen pentoxide, but, since solutions of this substance in organic solvents gave a different Raman spectrum, he supposed that the nitrogen pentoxide, when in solution in nitric or sulphuric acid, exists in some special form

Bennett and Williams have interpreted these results on the basis that Chédin's special form is an ionized form[2] In particular, they have assigned the line at 1,400 cm^{-1} to $NO_2{+}$, comparison with the iso-electronic molecule CO_2 having shown that a polarized Raman frequency would be expected to appear in this region They have attributed the line at 1,050 cm^{-1} to $NO_3{-}$, or, in the presence of sulphuric acid, to $HSO_4{-}$, assignments which are consistent with the known spectra of these ions.

The purpose of this note is to supply a spectroscopic demonstration of the correctness of Bennett and Williams's suggestion concerning the origin of the frequency 1,400 cm.$^{-1}$ it is an important suggestion, because it renders Raman spectroscopy the most convenient and certain method for the identification of $NO_2{+}$.

With the mixtures mentioned, Chédin had always obtained his two lines, 1,050 and 1,400 cm.$^{-1}$, together, and roughly in proportion to each other as regards intensity Neither he nor anyone else[3] has hitherto observed the line 1,400 cm.$^{-1}$ without the other line Chédin naturally assumed the two to originate in the same molecular source. The spectroscopic selection rules show, however, that, if two such lines should come from the same source, that source could not be $NO_2{+}$, for this belongs to the small class of molecules which cannot have more than one strong Raman line. It is permissible to avoid the difficulty by assigning the other line to either $NO_3{-}$ or $HSO_4{-}$; but the decisive experiment to determine whether the source of the line 1,400 cm^{-1} has in fact one or two lines in its Raman spectrum would, of course, be to produce the line 1,400 cm.$^{-1}$ without its hitherto constant companion, by mixing nitric acid with any other acid which (*a*) has no line in the neighbourhood of 1,050 cm.$^{-1}$, (*b*) gives an anion which has no line near 1,050 cm^{-1}, and (*c*) is a strong enough acid to destroy nitrate ion. Both perchloric acid and selenic acid fulfil these conditions; and we find that the addition of each of these acids to nitric acid produces a strong appearance of the Raman line at 1,400 cm^{-1} without any accompanying line at 1,050 cm^{-1}

The only molecules which possess but one fundamental Raman frequency are (i) diatomic molecules, (ii) linear, symmetrical, triatomic molecules In the present problem the former can be excluded on both spectroscopic and chemical grounds, and thus the demonstration given identifies the derivative of nitric acid responsible for the frequency 1,400 cm^{-1} as the linear, symmetrical, triatomic molecule $O=\overset{+}{N}=O$ Evidently the Raman-active stretching vibration, of frequency 1,400 cm^{-1}, is spectrally similar to the vibration of a diatomic molecule, the symmetry securing that during the vibration the central atom remains stationary.

Chedin obtained the lines 1050 and 1400 cm^{-1} from solid N_2O_5, which, we therefore suggest, may have the ionic structure $(NO_2{+})$ $(NO_3{-})$

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Derivation of Meteor Stream Radiants by Radio Reflexion Methods

SINCE October 1944 we have carried out investigations of the short duration scatter echoes observable in the neighbourhood of the *E* region of the ionosphere at frequencies well above the critical frequencies for either the normal or abnormal *E* layers The general occurrence of such echoes was first reported by Appleton, Naismith and Ingram[1] in their observations during the Polar Year 1932–33 Schafer and Goodall[2], who worked in collaboration with Skellett[3] in an investigation of meteors as a source of abnormal *E* region ionization, had also noted them as a specific feature of the Leonid shower of 1931 An adequate reference to subsequent research cannot be given in a brief communication, but the work has for the most part led to the view that the transient ionospheric echoes are caused by meteors (see, for example, Appleton[4]) Our experiments have led us to confirm that the majority of scatter echoes must be of meteoric origin and are due to reflexions from meteor trains or streaks these columns of ionized gas, caused by meteoric impact with the molecules of the upper atmosphere, present their maximum echoing areas when viewed at right angles to their length

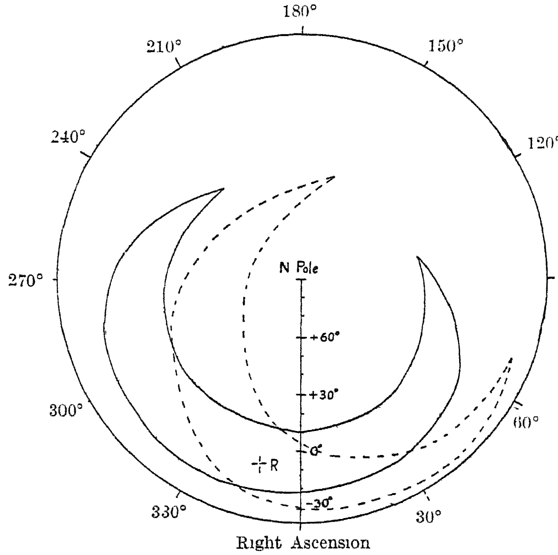

FIG 3 COVERAGE OF POSSIBLE RADIANT POSITIONS OF MAIN PEAKS OF STATIONS II AND III *R* IS THE DERIVED RADIANT Station II, ———— , Station III, - - - - - - -

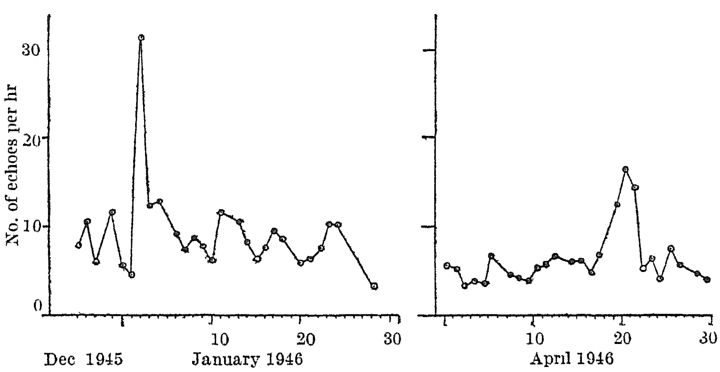

FIG 1 MEAN HOURLY ECHO RATE

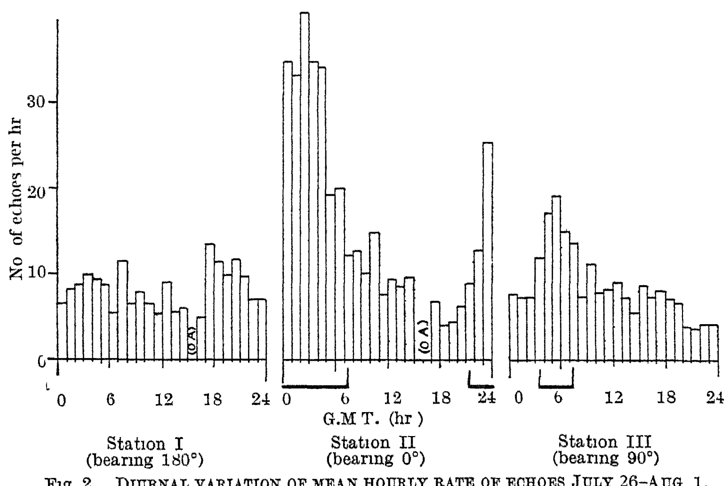

FIG. 2. DIURNAL VARIATION OF MEAN HOURLY RATE OF ECHOES JULY 26–AUG 1, 1945 TIMES AT WHICH RADIANT (R A 345°, DEC −10°) IS FAVOURABLE ARE INDICATED BY HEAVY LINES O.A, STATION OUT OF ACTION

In our investigations, pulse transmitters with Yagi aerials were operated on wave-lengths of 4–5 metres at 150 kW peak power With the radio beam directed vertically upwards, observations of scatter echoes were made simultaneously with a visual watch for meteors during the nights of April 20, 21 and 22, 1946. This revealed that those meteors which passed nearly overhead coincided with radio reflexions There were, in addition, about seven times as many radio echoes with no meteors seen It is well known that telescopic meteors exist in large numbers, so that it is reasonable to assume that many meteors not discernible to the naked eye may cause radio reflexions

To test this hypothesis we must consider whether the characteristics of all the echoes are such that they could be classified as of one type with a close correspondence to the properties of meteors One simple example is shown in Fig 1, in which the mean hourly rate of occurrence of echoes for a vertical-looking station is given for December 27, 1945–January 27, 1946, and for April 1–30, 1946 (the results are the average for 0915–1200 hr and 1400–1630 hr. G M T, except during April 20–22 when the times were 2030–2400 hr to coincide with the visual meteor watch) Reference to J P M. Prentice's Meteor Diary in the B.A.A Handbook, 1946, indicates that the important showers during these periods are the Quadrantids on January 3, 1946, of duration one day only, and the Lyrids, April 20–22, with a maximum on April 21 Fig 1 shows marked peaks coinciding both in date of incidence and duration with these two important showers

Even more striking has been the derivation of certain of the most active meteor radiants by means of stations with inclined beams set on different bearings It was discovered that the variation of diurnal rate was different according to the bearing of the equipment. Fig 2 shows the average of results obtained for the period July 26–August 1, 1945, for three stations on bearings 0°, 90° and 180° respectively. These results indicate that the echoing source is sensitive to aspect Assuming that the echoes are due to meteor trains or streaks presenting the most favourable aspect when viewed at right angles to their length, we have marked in Fig 3 the radiant positions corresponding to the peaks in hourly rate for Station II at 0230 hr and Station III at 0530 hr. These coverages of possible radiant directions intersect, and we may assume that the centre of overlap, *R* in Fig 3, is in the vicinity of a very active radiant The periods for which such a radiant is favourable may now be tabulated

Station	Bearing (O S Grid)	Period for which radiant is at right angles to radio beam
I	180°	Not favourable.
II	0°	Very favourable, 2140–0730 hr G M T
III	90°	Favourable, 0320–0710 hr. G M T

It is therefore evident that this radiant accounts well for the main diurnal variations shown in Fig 2 The position of the radiant is approximately R A 345°, Dec − 10°, which clearly indicates the δ Aquarids, a prominent stream of this epoch. This treatment has been successfully applied to other periods, and a detailed account of its application and of other properties of the scatter echoes will be published shortly The above techniques, which are capable of considerable refinement, open a new field for the meteor observer, and will enable him to observe the activity and radiant directions of the main meteor streams both by day and by night in all weathers

We wish to acknowledge the valuable assistance placed at our disposal by the G O C-in-C, A A Command, in watches prior to August 1945 We are indebted to the Director General of Scientific Research and Development (Defence), Ministry of Supply, for permission to publish this communication

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Short-lived Radioactivity from Lithium Bombarded with Neutrons

THE production of a short-lived activity as a result of the neutron bombardment of lithium was first reported in 1936 by Knol and Veldkamp[1], who found a β activity of period 0 8 sec after irradiating a lithium sample with slow neutrons from a 90 mc radium–beryllium source. This activity they ascribed to Li^8 formed according to the reaction

$$Li^7\ (n,\gamma)\ Li^8 \qquad (Q = +\ 1{\cdot}9\ \text{MeV.}). \quad . \qquad (1)$$

Rumbaugh, Roberts and Hafstad[2] afterwards pointed out that it should be possible to observe delayed α-particles from irradiated lithium due to the break up of the Be^8 formed from the β decay of Li^8 As they could find no delayed α-particles from Li^7 irradiated by a neutron source of a strength equivalent to 70,000 mc. of radon–beryllium they tentatively ascribed the activity observed by Knol and Veldkamp to He^6 produced by residual fast neutrons according to the reaction

$$Li^6\ (n,p)\ He^6 \qquad (Q = -\ 2{\cdot}9\ \text{MeV.}). \quad . \qquad (2)$$

As He^6 and Li^8 have almost identical periods, and Knol and Veldkamp measured only the period of their product, this interpretation of their results is quite permissible

Although the periods of Li^8 and He^6 are almost identical, the energies of the β-particles emitted are by no means so. The most reliable measurements[3,4] place the end point for the β-particles from Li^8 at 12 5 MeV., and those from He^6 at 3·5 MeV, and it is therefore possible to decide which of reactions (1) and (2) takes place during the neutron irradiation of lithium by comparing the energy of the β-particles emitted by the radioactive body of 0·8 sec half-life with the energies of the β-particles emitted from He^6 and Li^8 respectively In order to investigate these β-particle energies a sample of 20 5 gm. of lithium metal was irradiated by neutrons produced by bombarding targets of beryllium, boron or heavy phosphoric acid with 50 μA. of deuterons at 900 keV. For slow neutron irradiations both the target and the sample were surrounded by paraffin wax. Arrangements were made to interrupt the ion beam of the high voltage apparatus and to count the induced β-activity of the lithium for a period of a few seconds immediately following irradiation. Both the period and absorption in iron of the β-particles were measured, precautions being taken to eliminate background effects. The absorption curves obtained were compared with those measured under similar geometrical conditions using samples of boron carbide and of beryllium metal instead of lithium, which are known to yield Li^8 and He^6 according to the reactions

$$B^{11}\ (n,\alpha)\ Li^8 \qquad \text{and} \qquad Be^9\ (n,\alpha)\ He^6.$$

In this way it was established that the slow neutron irradiation of lithium leads to the production of Li^8 in accordance with reaction (1). Efforts were then made to detect the delayed α-particles due to the break-up of Be^8 using a lithium-coated ion chamber with the same irradiation technique, and evidence was obtained for the appearance of extra α-particles above the α-particle background produced by stray neutrons from the high-tension set. An estimate of the cross-section for process (1) was made by a comparison with the activity induced in an indium foil by the slow neutron source; the value obtained was

$$\sigma\ [Li^7\ (n,\gamma)\ Li^8] = \sim\ 10^{-27}\ \text{cm.}^2,$$

which is consistent with the upper limit given by Rumbaugh and Hafstad The number of delayed α-particles obtained in the lithium chamber was such that their observation would have been rather difficult with a source of the intensity used by Rumbaugh and Hafstad

Evidence has also been obtained that reaction (2) takes place when lithium is bombarded by fast neutrons, a weak activity exhibiting the absorption characteristics of He^6 being observed with neutrons of energies from 13 MeV. down to 4 MeV No effect of this type comparable in intensity with the Li^7 (n,γ) Li^8 process is obtained by slow neutron irradiation. This is consistent with the negative Q value for reaction (2).

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Thermal Etching of Silver

NUMEROUS workers have observed that polished surfaces of metal specimens frequently develop an etched appearance when the specimens are heated in atmospheres with which chemical reactions would not be expected Two types of etching effect have been recorded (*a*) the formation of grooves at the grain boundaries, and (*b*) the development, on the surfaces of crystal grains, of striations which change their direction at grain and twin boundaries In some cases the boundary grooves form when there are no striations, but when striations appear the boundaries invariably develop grooves Rosenhain and Ewen[1], heating silver, copper and zinc *in vacuo*, observed boundary grooves, and on heating silver in air both grooves and striations Together with Day and Austin[2], who observed grain boundary grooves in many different types of steel heated in hydrogen, they explained the development of grooves as being due to the preferential evaporation of metal from the grain boundaries Carpenter and Elam[3] observed the development of lines at the grain boundaries of an antimony-tin alloy (1½ per cent antimony), and said that the lines were really differences of level and were only produced on cooling Rawdon and Berglund[4] observed striations on iron heated in hydrogen and attributed them to slight volatilization of the polished surface. Johnson[5], heating tungsten in nitrogen and argon, observed striations in wires carrying direct current, which he ascribed to the migration of 'positive tungsten atom-cores' over the surface under the action of the electric field. Elam[6] found that when copper was heated *in vacuo*, striations only appeared when cuprous oxide was present, and explained their appearance as being due to the differential oxidation of the copper along certain crystallographic planes followed by the evaporation of the oxide Gwathmey and Benton[7], heating a spherical single crystal of copper in air at 0·3 mm. pressure, found that fine striations appeared which seemed to be due to the development of specific crystallographic planes in the surface. These striations were diminished when the specimen was heated in hydrogen at atmospheric pressure. Boas and Honeycombe[8] reported the occurrence of striations and boundary lines in specimens of tin, zinc and cadmium, heated and cooled through a number of cycles They suggested that the anisotropic expansion of the grains of these non-cubic metals caused plastic deformation in a randomly orientated aggregate and that the striations were slip lines.

We have heated samples of electrolytically polished high purity silver (99 9997 per cent purity) in various atmospheres at 920° C. and found that *in vacuo* (10^{-3} mm. pressure), in nitrogen and in hydrogen, grooves appeared at the grain boundaries and, very much less distinctly, at twin boundaries. When the specimens were heated in air and in oxygen at atmospheric pressure, in addition to grain boundary grooves, striations appeared on most of the crystals Specimens heated for eleven hours in air at different temperatures indicated that the grain boundary grooves started to appear at about 300° C and the striations at about 500° C. The higher the temperature of heating the greater was the proportion of crystals showing striations and the more closely spaced were the striations Specimens heated in oxygen showed in general closer spacing of the striations than those heated in air, and more frequently grains having striations in two directions (Fig. *A*).

A specimen heated in nitrogen for eleven hours at 920° C showed grain boundary grooves but no striations (Fig. *B*) After heating in air for one hour at the same temperature it showed marked striations (Fig. *C*).

A further heating in nitrogen for eleven hours caused the striations to disappear (Fig. *D*). Subsequent heating in air produced the striations once more in the same directions as before but more closely spaced.

To investigate whether boundary grooves and striations appeared at elevated temperatures or were produced on cooling, a technique was developed to enable photomicrographs to be taken at temperatures up to 940° C. These showed that both grooves and striations were present at elevated temperatures The behaviour of the metal over long periods while it was maintained at elevated temperatures was examined in this way, and it was found that the hard rolled silver specimens when heated to about 900° C recrystallized very rapidly, and then followed a period of relatively slow grain growth. The grains grew by the steady movement of the boundaries, and where there was no halt in the movement of the boundaries the grooves associated with them moved forward, leaving no traces of earlier grooves. Where for some reason there was a halt in the boundary movement, scars were left when the grain boundaries moved on. The striations were found to increase in number in any particular grain with time, and where a striated grain grew at the expense of its neigh-

A, SILVER HEATED IN OXYGEN FOR 11 HOURS AT 920° C (×2000), *B*, SILVER HEATED IN NITROGEN FOR 11 HOURS AT 920° C (×250), *C*, SAME FIELD AS *B*, AFTER SUBSEQUENT HEATING IN AIR FOR 1 HOUR AT 920° C (×250), *D*, SAME FIELD AS *B*, AFTER FURTHER HEATING IN NITROGEN FOR 11 HOURS AT 920° C (×250)

bour, the new material in that grain developed striations in the same direction as those already exhibited by the growing grain.

In considering an explanation of the phenomena of thermal etching observed in silver the following points arise That the striations in silver cannot be slip lines is clear, since the crystal structure of silver is cubic and it expands isotropically the striations increase in number with time when the metal is maintained at a constant temperature and heating in nitrogen causes their disappearance Since it has been shown by Benton and Drake[9] that, at a partial pressure of oxygen of 790 mm, silver oxide does not form above 200° C, the phenomena observed cannot be due to oxidation even when the silver is heated in oxygen, and the fact that new portions of grains show striations having the same direction as the striations already present means that the striations cannot be due to previous preferential oxidation of certain crystallographic planes

The following tentative explanation of the phenomena is offered When silver is heated in an inert atmosphere at constant temperature any changes which occur must be such as to reduce the free energy of the system, and it will approach the equilibrium conditions appropriate to that temperature As the boundary region between two grains is a region of less order than the regions within the grains themselves there is excess free energy at the boundary which can be pictured as a surface tension Where the boundary meets the surface, three surface tensions act at a line and the equilibrium condition is one where the surfaces meet at angles determined by the relative magnitudes of the surface tensions. For a positive surface tension in the boundary, therefore, the surfaces of adjacent grains should curve inwards at the boundary when equilibrium is approached and a groove appear on the surface The mechanisms by means of which the equilibrium configuration is approached can include those of preferential evaporation and ionic surface migration, and because of its lower activation energy the latter is probably the more important, especially at low temperatures

To explain the striations, it is necessary to assume that an adsorbed layer of oxygen so modifies the free energy of the surface that the condition of lowest free energy is not a plane but a stepped or corrugated surface This is possible if the planes exposed in the corrugations have free energies per unit area sufficiently below that of the original surface to compensate for the increase in area. Frenkel[10], in fact, maintains that the equilibrium surface of a crystal is not plane but stepped

It is intended to publish a detailed account of the experiments mentioned elsewhere

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Decay of Zinc Sulphide Type Phosphors

IN the derivation of the decay curve for phosphors of the recombination type with traps at one single depth, Randall and Wilkins[1] have assumed that there is no retrapping of electrons In a subsequent paper[2] they show, however, that the cross-sections for electron capture of the traps and the 'empty' luminescence centres are about equal After a long decay period there are many more empty traps than empty luminescence centres and consequently retrapping must be important

We endeavoured to calculate luminescence intensities over the whole decay period. We assumed that the traps have a depth E and are independent of the luminescence centres

If the number of trapped electrons is l per unit volume they escape at a rate γl, where

$$\gamma = s e^{-E/kT}, \quad . \quad . \quad . \quad . \quad (1)$$

and s is a constant[3]

The rate of retrapping of the free electrons is proportional to the number of empty traps per unit volume $(L - l)$, where L is the concentration of the traps, and to the number of free electrons n_e Then we can write

$$\frac{dl}{dt} = \alpha (L - l)\, n_e - \gamma l. \quad . \quad . \quad (2)$$

The rate of recombination of free electrons with ionized luminescence centres (holes) of concentration n is

$$\frac{dn}{dt} = -\beta n_e n. \quad . \quad . \quad . \quad . \quad (3)$$

We assume that each recombination process produces a light quantum and we define the emitted light intensity by

$$I = -\frac{dn}{dt}. \quad . \quad . \quad . \quad . \quad (4)$$

In the simplest case with only one type of luminescent centre

$$n_e = n - l. \quad . \quad . \quad . \quad . \quad (5)$$

Eliminating n_e and l from (2), (3) and (5) leads to

$$\frac{1}{n}\frac{d^2n}{dt^2} - \left(\frac{1}{n}\frac{dn}{dt}\right)^2 \left\{1 + \frac{\alpha}{\beta}\right\} + \frac{1}{n}\frac{dn}{dt} \{(\beta - \alpha)n + \alpha L + \gamma\} + \beta\gamma n = 0. \quad . \quad (6)$$

For long decay times this leads to a bimolecular law

$$\frac{dn}{dt} = -\beta R n^2, \quad . \quad . \quad . \quad . \quad (7)$$

where

$$R = \frac{\gamma}{\alpha L + \gamma}. \quad . \quad . \quad . \quad . \quad (8)$$

Thus from (3) the ratio of free electrons to holes tends to a constant value R

In terms of this ratio, putting $r = 1 - \frac{l}{n} = -\frac{1}{\beta n^2}\frac{dn}{dt}$ in (6)

$$\beta n^2 \frac{dr}{dn} = \alpha L + \gamma - \frac{\gamma}{r} + (\beta - \alpha)(1 - r)n \quad (9)$$

When $\beta = \alpha$ there is a very simple expression for r, namely,

$$r - r_0 = \{1 - e^{-(\beta L + \gamma)t}\}(R - r_0), \quad . \quad (10)$$

where r_0 = value of r at $t = 0$

The intensity as a function of time is then

$$I = \beta \frac{R + (r_0 - R)e^{-(\beta L + \gamma)t}}{\left[\frac{1}{n_0} + \beta R t + \frac{\beta(r_0 - R)}{\beta L + \gamma}\{1 - e^{-(\beta L + \gamma)t}\}\right]^2}. \quad (11)$$

n_0 and r_0 can easily be calculated as functions of I_0 if during excitation equilibrium has been reached.

The decay curves can then be calculated for different values of I_0 and for different temperatures

The accompanying figure gives some typical examples The following constants were used .

β = 10^{-14} cm.^{3} sec^{-1} [4]
s = 10^8 sec^{-1} [2]
E = 0 48 eV
L = 10^{16} cm.$^{-3}$

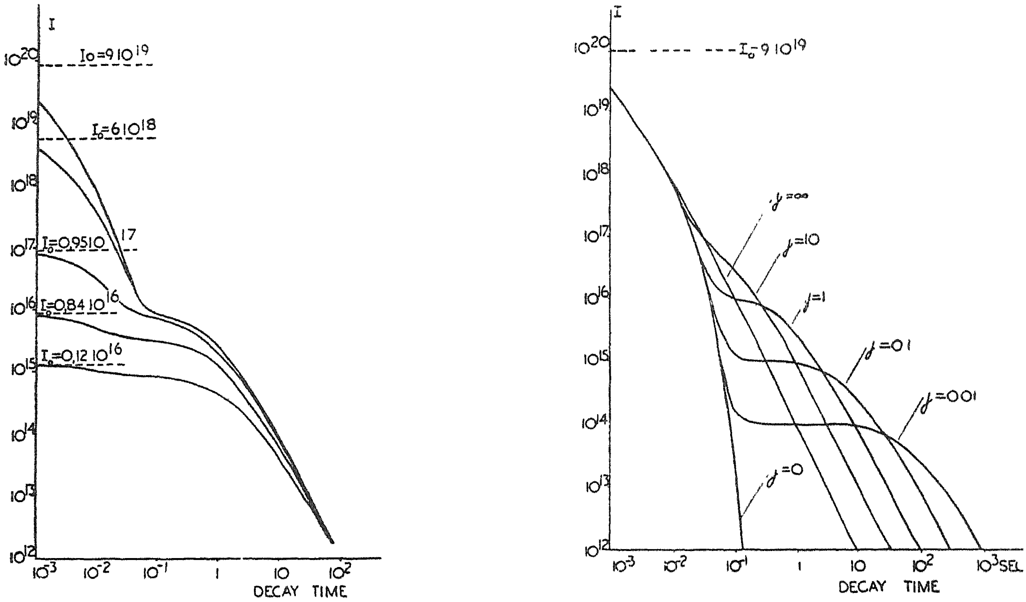
n_0 cannot, of course, exceed the concentration of luminescence centres, which is usually of the order of 10^{18}

The curves usually consist of two parts. The later part is obtained by neglecting the exponential terms in (11).

$$I \sim I' = \frac{I_0'}{\{1 + \sqrt{\beta R I_0'}\, t\}^2}, \quad . \quad . \quad (12)$$

where

$$I_0' = \frac{\beta R}{\left\{\frac{1}{n_0} + \frac{\beta(r_0 - R)}{\beta L + \gamma}\right\}^2}$$



THEORETICAL DECAY CURVES FOR DIFFERENT VALUES OF THE INITIAL INTENSITY AND FOR DIFFERENT TEMPERATURES

I' is strongly temperature-dependent and may be called phosphorescence in agreement with a suggestion put forward by Pringsheim[5]. I_0' is then the phosphorescence intensity extrapolated to $t = 0$.

r decreases during the decay to its asymptotic value R. At very low densities of excitation r_0 may be equal to R. The decay then reduces to one bimolecular curve. With increasing densities of excitation I_0' approaches an upper limit corresponding to $l_0 = L$ and $r_0 = 1$. The phosphorescence is then saturated.

At very low temperatures $I_0' = 0$. All traps are filled during excitation and the phosphorescence is then frozen in. The decay is bimolecular initially if $L \ll n$ but always changes to an exponential curve $(n - L \ll n)$.

At very high temperatures when $\gamma \gg \beta L$, the whole decay is given by

$$I = \frac{\beta n_0^2}{(1 + \beta n_0 t)^2}. \quad . \quad . \quad . \quad (13)$$

This corresponds to the "Obere Momentanzustand" of Lenard.

It can be seen from formulæ (8) and (1) that this occurs if

$$T > \frac{E}{k} \frac{1}{ln\ s/\beta L}, \quad . \quad . \quad . \quad (14)$$

in our example if $T > 400°$ K.

At room temperature no phosphorescence will be observed if $E \ll kT\ ln\ s/\beta L$.

In our example this would have occurred for trap depths less than 0 35 eV.

Fuller details will be published elsewhere.

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Diffraction of Light by Ultra-sonic Waves of Very High Frequencies

USING a specially constructed rectifier giving 1,100 volts and a Taylor *T* 55 valve with amphenol bases and special inductances, frequencies up to 100 megacycles per second have been produced. A tourmaline plate prepared in this laboratory with a thickness of 2 mm. and a fundamental of about 2 Mc./sec. is made to oscillate up to its 54th harmonic, and at all stages it could be employed to maintain stationary waves in a column of water in the usual manner. Diffraction patterns at almost all the frequencies in the range 2 to 100 Mc./sec. could be observed. The highest frequency so far adopted[1] for such work is only 52·5 Mc./sec In order to detect dispersion, if any, of ultra-sonic velocity in water, the crystal has been simultaneously excited by us at two frequencies and both patterns photographed on the same plate at the same instant.

Frequency measurement has been effected by beating the oscillator with a standard Philips heterodyne wave-meter, using an audio amplifier for hearing the beat note Results for two frequencies are given below, the temperature of water at the time of the experiment being 32·6° C.

Order of harmonic	ν Frequency in megacycles per second	d Fringe width in cm.	ν/d	Velocity calculated in metres per second
5	9·165	0·3655	25·89	1526
49	92·28	3·569	25·86	1524

Results may be taken as indicating that there is no dispersion of ultra-sonic velocity in distilled water. Bär's values when extrapolated to 32·6° C. give a velocity of 1,523 metres per second

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Symbiotic Aspects of Nitrification

IN an interesting article on the symbiosis between myxobacteria and nitrifying bacteria, Imsenecki[1] describes an observation which he made during his studies on the biology of myxobacteria, when he was able to isolate from a culture of *Nitrosomonas*, grown in its elective medium, a heterotrophic organism which he has named *Sorangium symbioticum* He postulates a symbiotic existence for these two organisms, suggesting that the development of the nitrifying bacteria precedes that of the myxobacteria, and that these chemotrophic nitrifiers synthesize the organic material needed for the heterotrophic organisms, afterwards making this available by the autolysis of the *Nitrosomonas* cells. Unfortunately no quantitative data have been published[1].

Since the question of the metabolism of the nitrifying bacteria has evoked considerable interest in recent years, it was thought worth while to record the observations made by me in an attempt to correlate the rather incompatible phenomena of nitrification by the classical organisms described by Winogradsky as it occurs in artificial cultures and in their natural environment. The possibilities that the nitrifying bacteria function in close association with the saprophytes of the soil, and that the nitrifying organisms are themselves heterotrophic in some stage of their lives were examined. It was shown[2] that when *Nitrosomonas* was cultured in its elective medium in the presence of organisms well known to take part in the transformations of nitrogen in the soil, as *B. megatherium*, *B mycoides*, *Azotobacter chroococcum*, etc, there was always enhanced nitrification in presence of added organic matter. These results question the strictly autotrophic character of the organisms tacitly assumed by Winogradsky and rather rigidly demonstrated by other workers. We have thus to assume that in mixed cultures, as in soil and sewage, the necessary carbon dioxide is obtained from the normal respiration of the heterotrophic bacteria and the organisms of nitrification behave as facultative heterotrophs Indeed, Beijerinck held the view of the mutability of the nitrifiers

A noteworthy finding in this connexion is that of Bomeke[3], who demonstrated the prevailing concept that the nitrifying bacteria possess no measurable metabolism other than the oxidation of ammonia and nitrite to be untenable, and that a heterotrophic dissimilation metabolism does exist, though only at a comparatively slow rate. From this point of view, the close correlation observed by Starkey[4] between the enhanced nitrification, carbon dioxide production and abundance of microbial population found in the regions of maximum root development is very significant The profuse use of oxygen by the nitrifying bacteria, contrasted with the fact that the adsorbed or condensed oxygen in soil has an unfavourable effect on the ordinary heterotrophic microflora of the soil emphasize the fact that organisms in their natural environments derive mutual benefit from one another Fermentable organic matter is rapidly destroyed by the saprophytes of the soil, rendering conditions favourable for vigorous nitrification Indeed, there is evidence to show that *Azotobacter chroococcum* could fix atmospheric nitrogen in the presence of different ammonium salts, and the enhanced nitrification observed in my experiments would be due to the greater amounts of ammonium salts present in the system as a result of nitrogen fixation by the *Azotobacter* fed by glucose Here, unlike as observed by Imsenecki, there are no autolytic effects suffered by the *Nitrosomonas* cells to render organic matter for the growth of the associate organisms, and consequently not the intriguing point of doubt as to how long such a symbiosis can proceed if at every stage the synthesized *Nitrosomonas* cells have to be expended to provide energy material for the growth of the myxobacteria

Thus it has to be recognized that a major part of nitrification occurring in Nature is brought about by bacteria which function in close association with the heterotrophic organisms of the soil, and the occurrence of a regulated chemomixotrophic metabolism seems established[5], at least for the organisms responsible for this moiety of nitrification In other words, nitrification in Nature is at least in part due to symbiotic agencies

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Formation of Hydrogen Peroxide by Spermatozoa and its Inhibitory Effect on Respiration

THE biological formation of hydrogen peroxide has often been postulated in the past, particularly in connexion with the presumed function of catalase and peroxidase, but so far its actual detection has been successful only in cultures of some bacteria[1,2,3] and some moulds[4,5] and in certain enzymic oxidations catalysed *in vitro* and requiring molecular oxygen for the oxidation of their respective substrates The chemical identification of H_2O_2 as a product of metabolic processes of animal tissues has up to now been unsuccessful Indirect evidence for H_2O_2 formation during respiration of bovine spermatozoa in egg-yolk medium has been submitted in a previous communication[6], and some evidence of its possible formation in human sperm has been given[7] Using suspensions of washed spermatozoa in presence of a substance separated from egg-yolk, we have now been able to demonstrate chemically the formation of hydrogen peroxide

In the previous communication[6] we showed that during respiration of whole semen diluted with egg-yolk medium, the rate of oxygen absorption gradually decreases As the cause of this inhibition of respiration we postulated a gradual formation of peroxide, since both catalase and peroxidase completely abolished this effect, while heat-inactivated catalase, cytochrome *c*, hæmatin and ferrous iron did not reverse it. Since then we have carried out a series of experiments using suspensions of washed spermatozoa, and we have found that inhibition of respiration develops in presence of egg-yolk or its dialysable portion Furthermore, we have isolated in considerable purity from the dialysable portion the substance which on oxidation by spermatozoa yields as a metabolic product the inhibitor of sperm respiration which we now identify as hydrogen peroxide

For the detection of H_2O_2 a suspension of washed spermatozoa containing 800 million cells in 3 925 ml *M*/15 phosphate buffer (*p*H 7 4) and 0 075 ml solution containing 1 8 mgm of the purified substance (a quantity comparable with that in a corresponding amount of egg-yolk medium) was shaken in air at 37° in a Barcroft–Dixon manometer After a certain time, when the inhibition of respiration had fully developed (1–1½ hr), the suspension was centrifuged and the clear supernatant fluid examined for the presence of H_2O_2 by means of the benzidine – peroxidase reaction, the optimum conditions of which were carefully predetermined so as to allow a maximum colour development in low concentrations of H_2O_2 The concentration of H_2O_2 formed was determined, by comparing the intensity of colour with that formed with known concentrations, and was found to be of the order of 10^{-1} µmol. H_2O_2/1 ml , this amount corresponding to about 1 µl. oxygen

That the inhibition is in fact caused by such low concentrations of H_2O_2 is supported also by the following evidence (*a*) The addition of 6×10^{-1} µmol H_2O_2 to 800 million washed spermatozoa suspended in 4 ml *M*/15 phosphate buffer (*p*H 7 4) almost completely inhibited the endogenous respiration of the spermatozoa, and lower concentrations gave correspondingly lower inhibition (*b*) In such experiments, if catalase was added at an early stage, before much damage was done to the spermatozoa, it almost completely reversed this inhibition, provided that all the intracellular substrates had not already been utilized At the end of experiment (*a*) it was not possible to detect H_2O_2 chemically, because a large part of the H_2O_2 added was eliminated from the system by the sperm However, H_2O_2 was detected at the end, if the original concentration added was 8×10^{-1} µmol H_2O_2 or higher The elimination of H_2O_2 by spermatozoa was quantitatively ascertained, in experiments with somewhat higher concentrations of H_2O_2, by estimating the amount of H_2O_2 with catalase before addition of the spermatozoa and after their incubation with H_2O_2 for an appropriate length of time. Thus, bovine spermatozoa must be equipped with a mechanism for the elimination of H_2O_2 from the system at a low rate

So far we have not been able to detect chemically H_2O_2 as a metabolic product of spermatozoa when their oxygen uptake was measured in presence of: (*a*) phosphate buffer alone, (*b*) egg-yolk medium, (*c*) the dialysable portion of the egg-yolk, (*d*) seminal plasma, (*e*) seminal plasma after yeast-fermentation, or (*f*) media containing either fructose or glucose Since in both egg-yolk medium (*b*) and the dialysable portion (*c*) the substance was present which gives rise to H_2O_2, and yet the latter was not detectable we suggest as a possibility that some constituent of the egg-yolk obscures detection of H_2O_2 by the benzidine peroxidase reaction.

The concentration of H_2O_2 present at any stage of respiration of the spermatozoa is, therefore, a result of two simultaneous yet diametrically opposed reactions, those of biological formation and elimination of H_2O_2. Its actual detection by the benzidine – peroxidase reaction is possible only if the rate of formation exceeds the rate of elimination by an amount which permits not less than 3×10^{-2} µmol H_2O_2 to accumulate in 3 ml of the supernatant fluid, provided that substances which interfere with the detection of H_2O_2 are absent from the medium in which the benzidine – peroxidase reaction is tried

A positive benzidine – peroxidase reaction is definite proof of H_2O_2 in concentrations at least as high as 3×10^{-2} µmol H_2O_2/3 ml of supernatant fluid, but a negative reaction need not necessarily mean that H_2O_2 is not formed during the metabolic processes of the spermatozoa.

Although we have proof of the formation and elimination of H_2O_2 by spermatozoa we cannot yet specify all the conditions which affect its detection. We can tentatively, at least, say, however, that the following are some of the necessary factors for its chemical detection . (*a*) an adequate concentration of active spermatozoa , (*b*) presence of a substrate, in sufficient concentration, which on oxidation by spermatozoa yields H_2O_2 , (*c*) a ratio between the rates of formation and elimination of H_2O_2 by spermatozoa such that not less than 3×10^{-2} µmol H_2O_2 in 3 ml of the supernatant fluid accumulates by the time the chemical test is made, and (*d*) absence of interfering substances present in complex organic media (for example, egg-yolk, seminal plasma) which may obscure detection of hydrogen peroxide by the benzidine–peroxidase reaction

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Vernalization of Sponge Gemmules

SPONGE gemmules were collected at Cambridge in September 1945 and brought to Glasgow in a small bottle of water from the River Cam On September 29, being impatient to make some observations on developing gemmules, I placed some of them in water from Loch Lomond in a refrigerator working at 50° F. The rest were kept in Cam water on my laboratory bench, where the temperature varied roughly between 55° and 65° F

On December 2, that is, after about two months had elapsed, single gemmules were cleaned so far as possible, placed each in the centre of a coverslip lying in a Petri dish of water from Loch Lomond, and so left on the laboratory bench.

Dish *A* contained 9 *Spongilla* gemmules from the refrigerator , dish *B* contained 8 *Ephydatia* gemmules from the refrigerator , dish *C* contained 17 *Spongilla* and 9 *Ephydatia* gemmules which had been kept all the time on the laboratory bench

A week later a white halo appeared around two of the *Spongilla* gemmules in dish *A*, and after another two days round two of the *Ephydatia* gemmules in dish *B*.

By December 21, development had begun in 7 of the 9 *Spongilla* gemmules in dish *A*, and in 7 of the 8 *Ephydatia* gemmules in dish *B* , while in dish *C* there was no sign of development in any of the gemmules of either genus Some of these, however, did develop later, for when the dishes were next inspected on February 24, 1946, one of the *Spongilla* and all the *Ephydatia* excepting three very small ones had evidently hatched out

Similar results were obtained in the second half of March, when the time of natural activity would be much nearer. All 26 gemmules (20 *Spongilla* and 6 *Ephydatia*) from the refrigerator had hatched ten days after being planted out in Petri dishes in natural water as before, while only 3 (all *Spongilla*) hatched out in that time of 28 gemmules (21 *Spongilla* and 7 *Ephydatia*) from the bench The time taken for development to have begun in all the vernalized gemmules (ten days) is less than in December (two to three weeks) , perhaps because the natural date of hatching was imminent, and/or because the temperature was a degree or two higher. Another batch of gemmules also, all *Ephydatia*, from a loch near Glasgow (for which I am indebted to Dr. Harry D. Slack of this Department), refrigerated only since December 2, gave 20 out of 24 gemmules hatching in the same ten days.

This method of vernalization is extremely simple and may well be more widely applicable to provide active material at desired times for students of all kinds, especially during the naturally inactive season of the year.

Its usefulness as a method of storage is, in this case at least, rather limited, for another set of gemmules similarly planted out early in May (by which date young sponges apparently developing from gemmules had already been found in Loch Lomond by Dr. Harry D. Slack) gave no development at all in three weeks of 22 *Ephydatia* gemmules still kept in the refrigerator, and 2 *Spongilla* out of 26 gemmules (23 *Spongilla* and 3 *Ephydatia*) kept on the laboratory bench.

Incidentally, little sponges grown in this way are excellent for showing the economy of a sponge and the activities of its constituent cells, including the action of the contractile vacuoles. A paper on this subject is in the press. Formation of young spicules could be observed from about the ninth day of the December cultures in *Spongilla*, and, even with no special attention to feeding the spongelets or to conditioning the water, oscula were developed, and the currents maintained by the choanocytes could be demonstrated over a period of two weeks or so, especially by the use of carmine particles or coloured food. The little sponge spreading out over the coverslip makes a beautiful permanent preparation.

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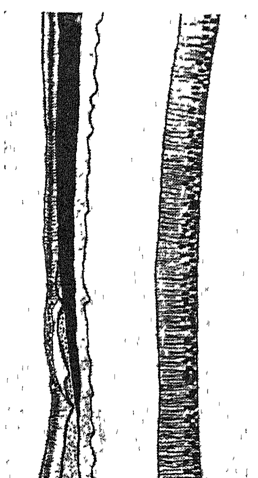
Enamel Formation in the Rat's Incisor Tooth

ACCOUNTS have been already published of the effects of vitamin D, alteration of the Ca : P ratio of the diet, and dietary restriction, upon the dentin of the incisors of rachitic rats[1]. It was noted during this work that the formation of organic enamel was sometimes upset by these procedures in animals on the Steenbock and Black rachitogenic diet of high Ca : P ratio, but that the organic enamel of animals made rachitic by low Ca : P ratio diets was scarcely ever affected. The fact that organic enamel formation in rats on a high Ca : P ratio diet is easily upset by various metabolic changes has been confirmed by recent experiments, which were undertaken in a different way and originally for another purpose[2]: after twenty-eight days on the usual Steenbock and Black diet, the animals were subjected to dietary restriction for 5–6 days. By this time it was found by examining a control rat that the epiphyses showed a well-marked 'line test' response. The remainder of the litter was then placed back on to full Steenbock and Black diet, and rats were killed and examined at intervals up to fifteen days thereafter, depending on the litter size and length of survival. Five litters of rats were treated in this way.

Examination of the upper incisor teeth at the third day of re-feeding showed that organic enamel formation had stopped. By the sixth day of re-feeding and sometimes earlier, the formation of organic enamel had begun again, often very irregularly at first, with globular material replacing proper enamel matrix. The old organic enamel matrix was not further laid down. This process is illustrated in the accompanying figure. The drawing was made from the tooth of a rat re-fed for twelve days. In some cases, as here, the proximal end of the old organic enamel was overlaid with globular material, and sometimes the new enamel overlapped the old to a slight extent. Measurements of the distance from the proximal end of the old enamel to the curve of Hertwig's epithelial sheath were made in four of the litters, and the distances plotted against the time of the events of the experiment. Extrapolation showed that enamel formation had stopped at the time the full diet was restored. The serum calcium, which was initially high, as is usual, fell somewhat when the animals' diet was restricted, and rose again when the full diet was given.



DIAGRAM, BASED ON A CAMERA LUCIDA DRAWING, OF THE ORGANIC ENAMEL AND DENTIN OF A RACHITIC RAT. (× 66.) *a* = AMELOBLASTS, *b* = ORGANIC ENAMEL, *c* = CALCIFIED DENTIN, *d* = PREDENTIN, *e* = ODONTOBLASTS. THE OLD ORGANIC ENAMEL IS DRAWN BLACK, AND THE GLOBULAR MATERIAL AND NEW ORGANIC ENAMEL ARE STIPPLED. THE PREDENTIN IS WIDE AS IS USUAL WITH THIS TYPE OF DIET. THE GAP BETWEEN THE GLOBULAR MATERIAL AND THE AMELOBLASTS IS AN ARTEFACT

The formation and maturation of the organic enamel were affected in different ways. The old enamel remained the same as when amelogenesis stopped, but calcified at about the same place along the tooth as it would have done if left undisturbed. It became slightly wider just prior to calcification, but was much narrower than normal at this point in the animals killed late in the experiment. The old proximal organic enamel retained the honeycomb structure typical of the deposition of new enamel (Wasserman[3]), although no more was formed and the ameloblasts over the old enamel were of the short variety. Once new enamel formation was established, it was accompanied by the presence of the normal tall ameloblasts associated with the formation of enamel (Diamond and Weinman[4], Wasserman[3,5]). The fact that the old organic enamel is associated with short ameloblasts and that it matures and calcifies, but little more is formed, is consistent with Wasserman's concept of these cells being active in enamel maturation only. The chief effect of the dietary change on the enamel organ existing at the time was to prevent the further formation of tall ameloblasts and to reduce those already present. As a result, enamel formation stopped, but maturation appeared to proceed normally. In certain places, especially at the proximal end of the old enamel, the ameloblasts were changed into small amorphous cells. Here granular material was laid down, but no enamel matrix, these cells apparently being able to form the former but not the latter.

The changes described above are similar in some ways to those found by Weinman[6] after strontium injections. In his experiments, however, the hypoplastic enamel matrix did not undergo maturation. Many other nutritional and endocrine conditions, such as magnesium or vitamin A deficiency or parathyroidectomy, also affect amelogenesis, but not in the same way as here.

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Tests for *Rh* Isosensitization of Red Cells in the Newborn

Coombs, Mourant and Race[1,2,3] have described an indirect method for the detection of weak and 'incomplete' *Rh* agglutinins in human serum, and a direct method for the detection of *in vivo* isosensitization of red cells in babies with hæmolytic disease. The tests have been found to work equally well with the following rabbit antisera after absorption with *A*, *B* and *O* cells: (1) rabbit anti-human pseudoglobulin; (2) rabbit anti-human-globulin; (3) rabbit anti-human-whole-serum. In the direct method the red cells of the baby are freed from serum by washing three times in a large volume of saline, a 2·5 per cent cell suspension in saline is then prepared and a drop of this suspension is mixed with a drop of the absorbed rabbit anti-human-serum. Cells which have been sensitized to the *Rh* factor show obvious agglutination within 5–10 minutes at room temperature.

The principle of the test has been explained on the basis that sensitized cells have antibody globulin adsorbed at some points on their surface and that when these cells are brought into contact with an anti-human globulin serum rapid agglutination results.

The test as described by the authors is simple and efficient, and will, no doubt, be utilized later as a routine test in the better equipped maternity hospitals to detect sensitization of the red cells of newborn babies. The use of this test offers a new field of research in various diseases for blood workers which they, no doubt, will be quick to grasp. The only difficulty the average laboratory worker will have to meet is the preparation of a high titre anti-human serum in rabbits, and the satisfactory absorption of this serum with normal *A*, *B* and *O* cells to remove the hetero-agglutinins for these cells. The test serum may, of course, be used at a dilution beyond the point at which the hetero-agglutinins are no longer active for normal cells but at which the serum agglutinates sensitized cells. This, of course, is a method of testing for potency any anti-human serum prepared in the rabbit, particularly with successive trial bleeds. Red cells may be sensitized *in vitro* with ease by adding two drops of selected blood to two drops of glucose-citrate and two drops of anti-Rh_0 'blocking' or 'incomplete' serum. The mixture is stood for one hour at 37° C., or room temperature, and the cells washed with saline and then re-suspended in saline to give a concentration of 2–5 per cent. The actual testing may be carried out on slides or tiles.

While work on this test was being conducted at these Laboratories it was decided to find out if the test would give positive results only with rabbit anti-human serum, and not with rabbit anti-sera prepared with the serum of various animals. This work was facilitated by having available small quantities of various precipitating sera which had been prepared in rabbits by Mr. J. J. Graydon and Mr. E. F. Woods during 1943–44 for use by Australian research workers in malarial studies. The methods of preparation quoted are those used by Graydon and Woods, to whom I acknowledge my gratitude for the serum samples and for the details of preparation. Two methods of preparing the serum antigens for rabbit immunization were employed.

(1) An alcohol precipitation, by mixing 40 ml. serum, 160 ml. saline and 500 ml. absolute alcohol. The mixture was stood at 5° C. or room temperature for 1–2 hr., centrifuged, and after the removal of the supernatant the deposit was re-suspended in normal saline equal to the original volume of the serum. The rabbits received doses of

6 ml I.P of the precipitated antigen suspension on approximately six successive days In some cases the rabbits also received additional doses of native serum and were bled 2–3 weeks later if the titres were satisfactory

(2) An alum-precipitated antigen prepared by the method of Proom[4] was also used The rabbits receiving this antigen were injected with 10 ml I M into both hind legs, and were finally bled approximately three weeks later

Both methods of immunization gave satisfactory precipitating sera, and these were used in the tests reported below The antisera on testing mostly gave positive precipitin ring tests with the homologous test serum when the latter was used at dilutions of 1/3,000–1/20,000. However, none of the rabbit anti-sera used by me when tested with *Rh* sensitized cells, after absorption with *A*, *B* and *O* cells, gave titres as good as those reported by Coombs *et al*

The rabbit anti-sera which had been prepared during 1943–44 contained 0 02 per cent 'Merthiolate' as a preservative and had been Seitz-filtered through E K pads, ampouled and stored at 5° C.

Results. The cells employed in the following tests were the washed red cells of a baby of Group *O* sensitized *in vivo*, normal cells of Group *O*, cells of Group *A* sensitized *in vitro* with a human serum of Group *A* containing pure anti-Rh_0 (Δ') 'blocking' or 'incomplete' antibody, normal cells of Group *A*, and normal cells of Group *B*.

Some rabbit anti-sera tested were first absorbed with *A*, *B* and *O* cells, and others were used diluted beyond the range of hetero-agglutination which, in most cases, did not extend beyond a dilution of 1/5 With some animal anti-sera heteroagglutination was seen only in the undiluted serum and then was extremely weak.

The following precipitating anti-sera prepared in rabbits gave positive results with *Rh* sensitized cells, and negative results with normal cells.

Rabbit anti-human	(2 lots)
Rabbit anti-porcine (pig)	(2 lots)
Rabbit anti-feline (cat)	(1 lot)
Rabbit anti-equine (horse)	(1 lot)
Rabbit anti-caprine (goat)	(2 lots)
Rabbit anti-canine (dog)	(1 lot)
Rabbit anti-bovine (ox)	(1 lot)

Negative results with *Rh* sensitized cells were obtained with rabbit anti-galline (fowl) (3 lots) Two of these anti-sera showed no evidence of hetero-agglutinins for normal *A*, *B* and *O* cells, while the other, prepared by the alum-precipitated method, showed the presence of heteroagglutinins only undiluted. Tests made on these anti-sera as a further check showed that they had not deteriorated as precipitating sera on storage for over two years at 5° C.

The above results are reported because they are interesting, and because data of this kind may help to throw further light on the immunological basis of the test described by Coombs, Mourant and Race. The test is one which promises to have wide applications and general use It should be noted that Coombs *et al* have shown that the test is not confined to *Rh* sensitization, but has been the means of detecting a new antigen and antibody. The test to date has been found to give negative results when the baby has hæmolytic disease due to blood group agglutinins anti-*A* or anti-*B*, and the reason for this has not yet been proved.

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The Incomplete Antibody: a Quantitative Aspect

It is widely believed that the titre of the incomplete or blocking (Δ') antibody, as determined by the quantitative 'saline test'[1], is dependent on the dilution of the anti-Rh_0 (Δ) serum added to the mixture of red cells and unknown serum[2] Coombs, Mourant and Race[3] stated in a recent article, "It is remarkable that the 'blocking' effect at this time still remained proof against our strongest Δ serum" However, if the incomplete antibody is 'univalent', as suggested by Wiener[4], and if the 'blocking' effect is a quantitative reaction, the presence or absence of agglutination in the 'saline test' would be expected to be dependent on the absolute amount of incomplete antibody (Δ') present and not on the amount of the anti-Rh_0 (Δ) serum added.

The results of the 'saline tests' with various dilutions of serum containing the anti-Rh_0 (Δ) serum provide some information of the nature of the reaction.

The serum containing incomplete antibody (Δ') was serially diluted with saline and to each dilution was added an equal volume of a 1 per cent suspension of Rh_0 (*cDe*) red cells The mixtures, which were made in small test tubes, were incubated at 37° C for thirty minutes A volume (equal to that already contained in the tube) of serum containing the anti-Rh_0 (Δ) agglutinin in high titre was then added to each tube, and the tubes incubated for a further sixty minutes At the end of this time a small quantity of the sedimented red cells was carefully removed from each tube with a fine capillary pipette and placed on a microscope slide. The cells were examined under the low power of the microscope for the presence or absence of agglutination. The titre of the incomplete antibody (Δ') was taken to be the last dilution of the unknown serum in which agglutination was absent.

Four different sera containing an incomplete antibody (Δ') were tested against various dilutions of the anti-Rh_0 (Δ), and all gave consistent results. A typical protocol is shown in the accompanying table.

	Dilution of serum containing incomplete antibody (Δ')				
Dilution of anti-Rh_0 (Δ) serum	1/2	1/4	1/8	1/32	1/128
1/2	—	—	+	+	+
1/4	—	—	+	+	+
1/8	—	—	+	+	+
1/10	—	—	+	+	+
1/20	—	—	+	+	+

The titre of the incomplete antibody (Δ') in the other three sera was similarly independent of the dilution of the serum containing anti-Rh_0 (Δ) agglutination

The results are consistent with the concept that there is a common receptor on the surface of the *Rh*-positive red cell for anti-Rh_0 (Δ) agglutinin and the incomplete antibody (Δ') If the incomplete antibody (Δ') forms a union with all these receptors then even large amounts of the anti-Rh_0 (Δ) serum will not produce agglutination On the other hand, if the amount of the incomplete antibody (Δ') present is insufficient to unite with all the receptors, added anti-Rh_0 (Δ) serum will unite with the remaining receptors and produce agglutination of the red cells However, although the results are consistent with this quantitative concept, they do not necessarily provide confirmation of this theory

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Testicle and Spermatic Tract Lesions in Lymphogranuloma Venereum

In a report on venereal diseases in West Africa by Lieut -Colonel R. R Willcox[1], when referring to other tropical conditions, he says. "Hydrocœles are very common in the African though considering the amount of gonorrhœa it is not surprising". According to him, lymphogranuloma venereum (inguinale) is also very common among these natives.

L V. is responsible for a certain number of cases of epididymal inflammations, many of them of a subclinical type[2–6], others, especially when the infection with Neisseria gonorrhœa has been simultaneous, with intense inflammatory symptoms. Some of these cases are accompanied by vaginalitis, which is rapidly reabsorbed, others follow a different course and hydrocœle is installed. Both subclinical or associated L V -gonorrhœa cases may follow a slow course and occasionally small epididymal abscesses adhere to the scrotum, break down and leave draining sinuses that heal spontaneously or under treatment. In all mentioned types, L V infection is seldom suspected[7].

In some cases the process mainly affects the blood-vessels and lymphatics of the spermatic cord, the vas or ductus deferens remaining normal or slightly enlarged. Thrombo-angiitis, phlebitis and lymphangitis with micro-abscess formation can be found on study of sections of these structures.

Lesions of L V. nature of the testicle proper have also been recorded[8,9]

Our observations have all been made in a country where filariasis is unknown

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National Service of Health,
Santiago, Chile Aug. 2.

[1] Willcox, R R., *Nature*, **157**, 416 (1946).
[2] Coutts and Vargas Zalazar, *Ann Malad Vener.*, **31**, 895 (1936).
[3] Sato Akira, *Japan J. Dermat. and Urol.*, **39**, 75 (1936)
[4] Bizzozero and Franchi, *Minerva Med.*, **2**, 241 (1937)
[5] Coutts and Martini Herrera, *Ztschr f Urol.*, **32**, 439 (1938)
[6] Huard and Joyeux, *Ann d'Anat. Pathol*, **16**, 228 (1939).
[7] Coutts, *Brit J Ven. Dis.*, **19**, 37 (1943).
[8] Bastos de Sequeira, *Bol. Soc. Med. e Cir. de Sao Paulo*, **26**, 13 (1942).
[9] Midana, *Dermatologica*, **85**, 403 (1942).

Dr Coutts's letter is very interesting as the writer has made a particular study of intra-urethral infections of lymphogranuloma venereum (inguinale)

As regards hydrocœles in West Africa, however, the matter of their origin is difficult to determine Gonorrhœa is extremely prevalent there and, apart from lymphogranuloma venereum, which is also very common, there are also filariasis, dracontiasis and schistosomiasis, as well as other genito-urinary conditions, which may subscribe to their production.

As a basis of probability, gonorrhœa is singled out as the most likely antecedent while the other diseases mentioned are probably more common causes than the comparatively rare one of lymphogranuloma venereum. This matter is very hard to prove as a hydrocœle in a patient showing a positive Frei test is by no means proof that the hydrocœle is due to lymphogranuloma venereum, as the Frei test may remain positive for a very long time after infection.

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RESEARCH ITEMS

Food of the Wigeon

INVESTIGATIONS by J. W. Campbell at North Uist into the food habits of the wigeon (*Anas penelope*) have shown that the widely held opinion that the broad-leaved *Zostera* is the main food of these ducks needs qualification. In some areas *Ruppia* was found to be preferred to all other foods, and the narrow-leaved *Zostera* was found to be eaten in greater quantities than the broad. In recording these results, Campbell stresses the need for observations of the bird's environment before statements, which are often based on stomach analyses alone, are made about food habits. In the inquiries at North Uist attention was paid to the locality, foods available, mode of capture, season when obtained, activities prior to capture, field observations on feeding habits, age, weather conditions, and the competitors for food. Similar work was carried out on the feeding habits of the brent goose (*Branta bernicla*).

Diurnal Variation in Tumour Production

J. C. MOTTRAM (*J. Path. Bact.*, 56, 181 and 391; 1944) described a method whereby an abundance of tumours could be produced by a single application of benzpyrene to the skin of mice. He found that the yield of tumours depended on the degree of mitotic activity in the epidermis at the time of application, which suggested that benzpyrene acts only on dividing cells. There is known to be a marked diurnal variation of mitosis in the epidermis of mice, with a maximum at midnight and a minimum at midday. Midnight application of benzpyrene should therefore yield more tumours than midday application, and such proves to be the case. Mottram (*J. Path. Bact.*, **57**, 265; 1946), using groups of mice, painted one flank at midnight and the opposite flank at midday with the result that about twice as many tumours developed on the midnight flank as on the midday one. Control of lighting conditions did not influence the result.

Blood Viscosity and Rate of Oxygen Exchange

J. Fegler and J. Banister (*Quart. J. Exp. Physiol.*, 33, 163; 1946) describe a special form of tonometer for measuring the rates of oxygen and carbon dioxide exchange of blood *in vitro*. Study of various factors influencing the rate of oxygen exchange showed that blood viscosity was often the underlying limiting factor. Rise of temperature (from 22° to 38° C.), or reduction in red cell concentration, increased the rates of uptake and release of oxygen, and the increases could be exactly accounted for by the concomitant decreases in viscosity.

Skeletal Anatomy of Fleas

UNDER this title, the well-known American insect morphologist, Dr. R. E. Snodgrass, has published a very detailed anatomical study of the skeletal parts of adult fleas (*Smithsonian Mis. Coll.*, **104**, No. 18). The adult flea, it may be added, is an extremely specialized creature showing no very clear affinities with any other order of insects. What few indications it does give have led many entomologists to conclude that it has relationships either with the Mecoptera or the Diptera, or possibly with both these orders. The object of the present memoir, the author states, is to interpret the skeletal anatomy of fleas according to the general principles of insect morphology. His account of the mouth-parts includes a discussion of the homologies of the organs concerned. He discards the older interpretations and regards the paired stylets as being the laciniæ of the maxillæ and not the mandibles, as has been usually believed. The musculature of these stylets is in accordance with that of the insect maxillæ, and the unpaired stylet is accepted as being the greatly drawn-out epipharynx. The food channel is the minute tube formed laterally by the curved inner walls of the laciniæ combined above with the epipharynx. Concrete evidence of the winged ancestry of fleas is apparently revealed (as was first shown in 1935 by Sharif) by the presence of what seem to be vestiges of true wing-buds on the mesothorax of the pupa of certain species. The male genitalia come in for detailed treatment, and, as the author remarks, are probably the most complicated apparatus of their kind to be found in all the Insecta. The memoir is illustrated by 21 plates portraying many anatomical details of structure.

Purification of Tobacco Mosaic Virus

ESTIMATIONS of the size and shape of tobacco mosaic virus have often given conflicting results which suggest that it could occur in a range of different sizes. F. C. Bawden and N. W. Pirie (*Brit. J. Exp. Path.*, 26, 294; 1945) confirm this and show that the properties of different preparations can vary much more than was previously suspected. Tobacco mosaic virus aggregates with the constituents of sap of its host plant, and with other agents. A method for minimizing the aggregation of virus as extracted from plant sap is described, and it is shown that virus can be separated by differential ultracentrifuging into fractions with widely different properties. The most rapidly sedimenting fractions contain little but virus nucleoprotein; the slower deposited fractions have little virus, which has indeed different serological and physical properties from the earlier deposited virus. All fractions are unstable and rapidly assume the serological behaviour of flagellar antigens, with intense anisotropy of flow. This change is usually accompanied by the elimination of non-virus material. The primary virus particle seems to be small, not greatly elongated, and combined with extraneous material in the plant. Removal of this matrix allows the virus to combine into the rod-shaped masses in which it is commonly found.

Effect of X-Rays upon Agricultural Seeds

IN 1940 the Svalof Plant Breeding Station began an extensive programme of the induction of mutations for plant-breeding by radiation with X-rays. A. Gustafson (*Hereditas*, 30, 165; 1944) describes the effects of treating dormant seeds of various crops with X-rays. The critical dosage above which great lethality occurs varies considerably between species. Thus peas require about 7,500 r., but *Brassica napus* and *Linum* are still highly resistant at more than 50,000 r. The author points out the X-rays were hard (highly penetrating) and that the resistance was probably due to the oily or fatty nature of the cell contents. A useful table of critical doses is provided.

Sunspots and Magneto-Hydrodynamic Waves

HANNES ALFVÉN has put forward a new theory of sunspots (see *Nature*, 157, 522, April 20), and a second paper on the subject has now appeared (*Mon. Not. Roy. Astro. Soc.*, 105, 382; 1945). The main object of this paper is to discuss the shape and orientation of the magneto-hydrodynamic whirl rings created in the solar core. Theory requires that a bipolar sunspot is produced when a whirl ring intersects the solar surface;

when the ring reaches the surface, two sunspots of different polarities, created very close together, would be expected, provided no secondary phenomena existed. The subsequent behaviour of the spots conforms largely to theoretical predictions, except the last phase, in which the spots are not often observed to move close together again and disappear, as theory requires. Observations of the shape of the bipolar sunspot make it possible to construct the shape of the whirl ring, and three diagrams show these. During the motion from the core outwards, the whirl rings are deformed because of the changes in the magnetic field and the velocity; in the case of a homogeneous field out to about $1 \cdot 4 \times 10^{10}$ cm. the whirl is almost circular, and it is also circular for a dipole field outside this limit. An investigation of the motion of a whirl proceeding as a magneto-hydrodynamic wave in a liquid with variable density under the action of gravitation shows that when the whirl velocity is high, the acceleration or retardation is most rapid for whirls with planes parallel to the magnetic field. The results are applied to conditions in the sun, and it is shown that it is impossible to adopt the current stellar models of the sun—a convective core from the centre to about 10^{10} cm. and a non-convective region outside this limit—because convection in one part of the sun causes magneto-hydrodynamic waves which give rise to convection in other parts also, and it is not appropriate to speak of a 'non-convective' region. No account has been taken of the Coriolis force, and it is admitted that ignoring it is one of the most conspicuous deficiencies of the theory. An exact treatment of its effect, however, encounters mathematical difficulties.

Theory of Pulsating-Field Machines

A PAPER by Dr. Robert Pohl (*J. Inst. Elec. Eng.*, 93, Pt. 2, No. 31, February 1946) suggests that, instead of attempting to adapt the rotating-field theory to pulsating field machines, it is more satisfactory to employ an independent theory developed by finding an expression for the pulsating permeance of the magnetic path and considering the total magneto-motive force acting upon that permeance, both on open-circuit and on load. A new method for determining rapidly the air-path permeance as a function of time leads to the 'belt characteristics', thence to the electromotive force and its wave-form on open-circuit, to the armature reaction including its effect on the wave-form, and to the necessary excitation for a given load. The analytical results are supplemented by simple vector diagrams. The means for controlling the wave-form are then discussed, among them a new device for eliminating undesirable odd harmonics in addition to the even harmonics. Finally, suggestions are made for simplifying the work in design offices by standardizing the most favourable slotting and the corresponding characteristics.

Phthioic Acid

PHTHIOIC acid, $C_{26}H_{52}O_2$, is a liquid saturated fatty acid isolated from the lipoids of tubercle bacilli, and has been claimed to be the specific cellular stimulant responsible for the tubercle. N. Polgar and Sir Robert Robinson (*J. Chem. Soc.*, 389; 1945) summarize previous attempts to find its constitution, and point out that the evidence suggests that the phthioic acid molecule contains only one long chain, which must have a greater length than previously thought possible on the X-ray evidence. This view is confirmed by the experiments recorded in the paper. A number of analogous long-chain acids were synthesized, and they show film properties analogous to those of phthioic acid. The structure $CH_3[CH_2]_3.CHMe[CH_2]_5.CHMe[CH_2]_9.CHMe.CH_2.CO_2H$ is shown to be feasible by the synthesis of the substance which is found to have properties tallying with those of phthioic acid.

Dry Ice

SOLID carbon dioxide, commonly known as 'dry ice', with a sublimation temperature of $-78 \cdot 5^\circ$ C., is a commercial product, which has found many applications. H. N. Brown (*J. Franklin Inst.*, 240, 487) describes equipment using dry ice as a source of cold which can be applied in testing or other low-temperature work, for example, in testing small electronic parts on a mass-production basis. This is much simpler than conventional refrigerating machinery. The apparatus consists of test chambers with close-coupled piping and positive-pressure blowers circulating cold gas liberated from dry ice containers. Rate of temperature change is achieved by valve adjustment. Testing other materials, and metal shrinking and other low-temperature treatment could be carried out with such equipment.

Constitution of Trumpler's Star NGC 6871,5

JAAKKO TUOMINEN has published a number of papers on Trumpler's stars, in which their observed luminosities were compared with the theoretical results derived from Eddington's mass-luminosity formula, and also his theory to explain the differences is expounded. In a recent paper (*Mon. Not. Roy. Astro. Soc.*, 105, 256; 1945) Tuominen discusses the relatively low luminosities of Trumpler's stars, as compared with Eddington's mass-luminosity formula. This formula is based on the assumption that there is a purely radiative transfer of heat throughout the star; but the theory that the transfer of heat is partly convectional and partly radiative is now adopted. To avoid very high turbulent speeds, it is necessary that the density should rise relatively quickly from the surface inwards. The density is assumed constant in the innermost part of the star, but it may decrease inwards, and this is explicable from the fact that radial convection currents are hampered by a high turbulent viscosity. The turbulence is maintained by large-scale currents, and subatomic heat is responsible for keeping the whole mechanism going.

Variations in the Lunar Formation Aristarchus

IN a paper on this subject, H. Percy Wilkins (*J. Brit. Astro. Assoc.*, 56, 1, December 1945) suggests a possible explanation of certain 'glows' on the surface of the moon, with special reference to those associated with Aristarchus, in which dusky streaks have often been noticed. The majority of the fluorescent or glow effects observed within Aristarchus and in connexion with other objects have been detected around the period of sunspot maximum, and it is suggested that these glows may be caused by electronic impact due to electrons emitted by the sun striking the lunar surface. The theory postulates that certain portions of the lunar surface consist of materials capable of deflecting electrons, or alternatively, the emission of gases like argon from the deeper cavities or clefts. The theory is very interesting, and it is to be hoped that further research will be carried out on the subject.

INDIAN SPECIES OF *ARISÆMA*

By Dr. D. CHATTERJEE
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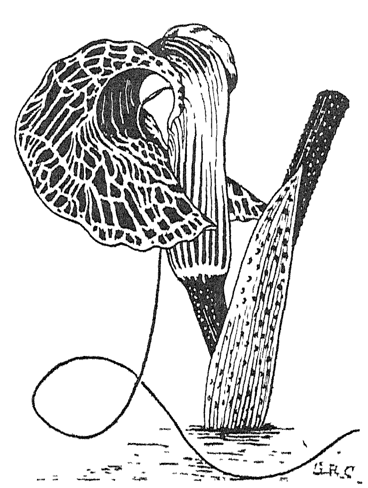
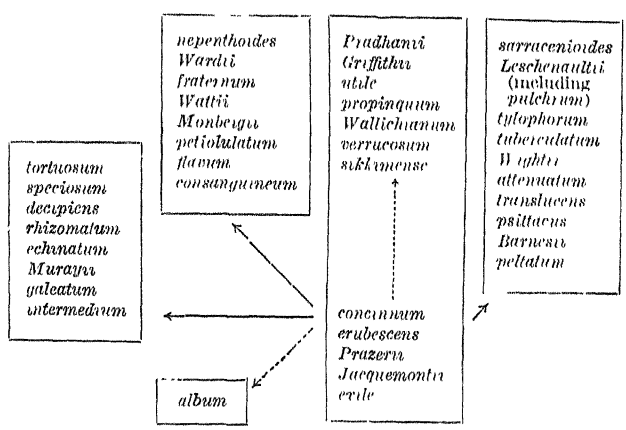
THE arum family (Araceæ) is well represented in tropical parts of the world, and, in India, genera like *Colocasia, Alocasia, Typhonium, Amorphophallus* and *Pothos* belonging to this family are commonly found. Some of these genera are associated with the hydrophytes and others form constituent plants of the secondary vegetation of the '*terai*' forests or the foothill vegetation of the Himalayas. The '*terai*' should be regarded ecologically as the real tropical rain forest. The arum family as a whole, therefore, comprises plants which are not found in high altitudes in India in places like Simla, Darjeeling or Sikkim. We are apt to think of plants like lofty *Magnolias, Cedrus, Quercus, Rhododendrons* and other plants like *Primulas, Gentianas* and *Senecios* when we imagine the vegetation at high altitudes in the Himalayas. An exception to this is the interesting and fascinating genus *Arisæma* belonging to the arum family. The species of this genus are always found in high hills and some reach altitudes of 15,000 ft. (5,000 m.) in the Sikkim Himalayas.

Some of the Himalayan *Arisæmas* are plants of great beauty, and their cultivation in gardens of temperate countries should open up a novel line to horticulture. The peculiar hood-like and deeply coloured spathe is the most attractive part of the plant, and species like *A. Pradhanii* (see accompanying figure), *A. Griffithii, A. utile, A. Wallichianum, A. sarracenioides* and *A. nepenthoides* should find a ready appeal to plant lovers. The coloration of the spathe of *A. Pradhanii* is described by Dr. Cromar-Watt of Aberdeen as follows: "When seen in sunshine the spathe looks more like some burnished metal than any vegetable production. A combination of velvety chocolate purple, chrysoprase green and pearly white with ribs of shining burnished copper in the inside." The plants flourish well in a cool greenhouse in a compost of rich loam, decayed leaf mould and sharp sand. They require plenty of moisture during the growing season, but afterwards they should be kept moderately dry and rested during the winter months.



Our knowledge of the Indian species has been enriched in recent years by some fine collections made in the South Indian hills by the late Prof. E. Barnes of Madras. Although Prof. Barnes was a chemist and had been teaching chemistry in India, his casual interest in plant collections has resulted in the discovery of eight new species of *Arisæma*. It is now possible in view of ampler materials to study the group and the interrelationship of the species. Hitherto, no one has attempted to arrange the Indian species in natural groups excepting perhaps Engler ("Pflanzenreich—Araceæ", 1920). Unfortunately, Engler's first group, *Fimbriata*, does not seem to contain plants with a simple spathe and appendix. Besides, there are fourteen other groups, and although some of them contain plants of natural alliance the interrelationship of the groups are somewhat obscured by sorting some one hundred species into fifteen groups. The Indian species should have a basic plexus in plants like *A. exile* and *A. Jacquemontii* and not in *A. alba* of the *Fimbriata* group as proposed by Engler. I have attempted a simpler arrangement, and the species have been sorted in four main groups. The linear development from the basic species *A. exile* ends in *A. Griffithii* and *A. Pradhanii*. A parallel development is indicated in south India and the line must have separated from the main phase early in the evolutionary history. Besides these, there are two other smaller developments in northern India ending with species like *A. tortuosum* and *A. nepenthoides*. The general plan of *Arisæma* may be outlined as shown below:



A detailed account of the Indian *Arisæmas* has been prepared and will be published elsewhere.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX

ANNUAL CONFERENCE

THE twenty-first annual Conference of the Association of Special Libraries and Information Bureaux, held at the Polytechnic, Regent Street, London, during September 13–15, while less well attended than the previous conference and possessing the advantage of a single venue, was scarcely so successful in providing the opportunities for informal discussion and contacts, apart from the conversazione with which the Conference opened. This was again followed by the annual general meeting, and the reports submitted to that meeting on the year's work again showed an increase in membership, which now stands at 712, and an increase in the subscriptions to £2,215. The honorary treasurer was able to report a surplus for the year on the income and expenditure account of £671, and in addition to grants of £300 from the British Council and £1,000 from the Department of Scientific and Industrial Research, the income included £253 from the Documentary Reproduction Service recently established. In view of the discussions at the previous Conference, a special Policy Committee was appointed during the year to review the memorandum and articles of association, to make recommendations regarding the relation between the Council and its committees and on the internal organisation of the Association. Certain broad proposals for the alteration of the articles of association were approved by the annual general meeting, and legal aid will now be obtained in redrafting, having regard, however, to the relations of the Association with the British Society for International Bibliography. Establishment of a special joint committee of the two bodies to work out a definite scheme of co-operation or possible coalescence was also approved by the annual general meeting, when Sir Reginald Stradling was elected president, Mr. T. M. Herbert re-elected honorary secretary, and Miss I. M. Shrigley honorary treasurer.

In his presidential address at the first session of the Conference, Sir Reginald Stradling discussed "The Place of the Intelligence Group in a Technical Team", dealing particularly with its place in the group of industries concerned with building and civil engineering with which he is connected. Sir Reginald pointed out first that in research on the problems of an old traditional industry there are usually no ready-trained scientific workers, and there is no division of science specifically directed to the practical need of the industry. The service of such large-scale human needs as building demands a combination of many branches of science, each contributing its own quota to the development of the applied science required. This determines the type of organisation required; and stressing the vital importance of team-work, which must provide for the biological and social sciences as well as the physical, Sir Reginald emphasized that the problem of the leader of such a research team is to create the conditions under which his specialist colleagues can work without the feeling of frustration which results from too much regimentation. In creating such conditions the intelligence group often holds a key position in a research team, and Sir Reginald devoted most of his address to a discussion of the qualities desired in such an intelligence officer and of the training of senior men for such work. That training, he thought, should be as wide as possible, with a general degree in science as a minimum, industrial experience and two or more foreign languages. Moreover, selection by academic standards only is useless; although the presence in a research team of a man intimately acquainted with the resources of information at his disposal and also understanding the requirements of the research worker and fully and professionally aware of the team's objectives is one of the major advantages of team-work, recent trends in official circles suggest that the value of scientifically trained leaders in intelligence work is not yet appreciated. Sir Reginald Stradling's persuasive presentation of the dynamic aspects of intelligence work and library service concluded with a brief survey of the activities of the Association of Special Libraries and Information Bureaux, in which he referred to the steady growth in the industrial membership and indicated a future for the Association more on the lines of a learned society. We now particularly need to explore, he said, the best methods of getting the information already collected used effectively.

Following the presidential address, Mr. Theodore Besterman presided over a session at which Mr. A. D. Roberts presented a paper on "The Preparation and Coverage of Critical and Select Bibliographies". Mr. Roberts distinguished three types of bibliography: select and critical bibliographies of the literature of one subject as it stands at a named time; critical bibliographies published serially or in serials; and guides to the literature of various subjects. Works of the first class have always been needed by librarians and by subject specialists, and Mr. Roberts cited a number of examples drawn from various branches of science, pointing out both the need for sifting material for inclusion and referring to the difference of opinion as to what should be included. He also stressed the value of classification so as to facilitate their wider use and incorporation, but neither in his paper nor in the discussion that followed was the important point made that the basis of selection (other than a period basis) should be clearly stated. The effort involved in doing this might eliminate some of the disagreement between experts to which Mr. Roberts referred. Commenting on the second type of bibliography, Mr. Roberts emphasized the need for good critical surveys of many more subjects to enable men of science and librarians to get quickly at the most important writings on scientific subjects, thus reducing the necessity for laborious searches. In some subjects there is a need for critical literature surveys at different levels; and commenting on the tendency, in annual review volumes dealing with scientific subjects, to limit the survey to periodical articles, Mr. Roberts stressed the value of including monographs and books published during the period and also of quoting authoritative reviews for the works entered. Mr. Roberts recognized the limitations of such bibliographies and directed attention to the desirability of abstracting services doing more than list literature surveys without comment His third type of bibliography covers a larger field, and very few books of this type have been published apart from some efforts in chemistry. Here, above all, it is important that the compiler of the bibliography should indicate clearly the class of reader to whom his work is addressed and the basis of selection. Indifference to these elementary principles has been responsible for much unsatisfactory work in all three types of bibliography, and yet neither in the paper itself nor in the discussion, except perhaps in a remark of Mr. Greenaway, of Messrs. Kodak, Ltd., regarding the date or period of a bibliography, did they appear to be sufficiently appreciated.

The paper "What an Industrialist Expects of an Information Service", which Sir Arthur Fleming and Miss B. M. Dent read before the following session, proved scarcely as challenging as might have been expected. Sir Arthur indeed, after stressing the importance of new knowledge and ideas in industry as a condition of progress, said that the industrialist requires accurate and comprehensive information and needs it quickly; but for the rest he contented himself with describing the information service developed during the last thirty years to meet the needs of the research and other departments of the Metropolitan-Vickers Electrical Co., Ltd. Sir Arthur paid tribute to the pioneer work of Mr J. G. Pearce in the development of this service, the cost of which now he put at about £10,000 a year. A recent development is the issue weekly from 1945, in response to a request from the works senior staff, of an *Industrial Digest*, each number of which contains about fifty brief abstracts on factory processes and workshop practice likely to be of interest to factory executives.

Sir Arthur Fleming's paper was followed by one from Prof. R. S. Hutton on the communication of specialist information to business executives, in which he emphasized that the problem of bridging the gap between the academic world and the so-called practical man is essentially one of interpretation. There are psychological factors, and the scientific worker sometimes pays too little attention to the consideration of the most appropriate form of communication; but Prof. Hutton stressed the importance of clear and brief exposition. Referring to T. H. Huxley and W. H. Hudson as examples, he urged that however important clear expression and the planning of reports may be, the prime necessity is to concentrate attention on the actual target to which one's written or spoken word is directed. This aspect of the work of the research associations is of increasing importance, and Prof. Hutton concluded his paper with some hints to the individual information officer and a plea for more imagination, alertness and experience to be brought to bear on the problems of exposition and interpretation. While Prof. Hutton's remarks were generally appreciated, it seemed clear from the brief discussion which followed that the effective communication of scientific and technical information demands not merely much skill on the part of the research worker and information officer but also a considerable improvement in the general standard of education and scientific training of the average business executive himself. An evening session at which Dr. L. J. Comrie, of the Scientific Computing Service, Ltd., presented a paper on "Machines and Tables" closed the proceedings on September 14.

The opening session on September 15, over which Mr. A. E. Cummins presided, was given over to a symposium of papers on some aspects of documentation in Europe to-day. Although short papers by John Ansteinsson on special library facilities in Norway, by Dr. F. Steggerda on the present position of information services in the Netherlands, by Dr. Erik Hernlin on the technical information service in Sweden, by W. Janicki on the Swiss Centre of Documentation, and by J. Wyart on scientific and technical documentation in France were circulated in advance and not read at the Conference, quite inadequate time was allowed for discussion on present conditions in Germany. If the first paper at this session, by Mrs. J. Lancaster-Jones, on "Some Aspects of the Demand for British Scientific and Technical Books for Europe", could be allowed as a contribution to the particular theme under discussion, Miss Esther Simpson's account of the Society of Visiting Scientists seemed irrelevant, and the Conference's organisers failed to gauge the strength of the desire for full information about the position in Germany, especially from British observers. In the absence of Mr. Ronald Fraser, of the Control Commission for Germany and Austria, present conditions in Germany were described by Colonel P. K. Blount, who had just returned from Germany for the purpose, and by Mr. K. Garsides. It would be impossible to do justice to either speaker's contribution here by attempting to summarize their account of the position of the university and technical libraries in the British Zone, beyond the statement that roughly some fifty per cent of the holdings of books in both British and American zones have been destroyed. As regards periodicals, little was added to the picture of chemical publications given by Dr. Conant in his report to the American Chemical Society, except to indicate some better prospect of the continuation of "Beilstein's Handbuch". Colonel Blount indicated that British policy favours the resumption of old, rather than the initiation of new, periodicals. The general impression left by the papers themselves, by the chairman's own contribution and by the whole of the lively discussion, was that far too little has been done to secure for Great Britain either books or sets of periodicals published in Germany during the War, and that the energy of the Library of Congress Bureau and other American activities have now left the field bare. Dr. Hutton cited examples of action taken by the Cambridge University Library which enabled that Library to complete its holdings of the German periodicals to which it had subscribed in 1939, and similar action may have been taken by other British libraries. A resolution moved by the chairman was unanimously adopted, urging the Council to give close consideration to the whole position with the view of urging appropriate action on the British authorities. Beyond this, however, the session gave some disconcerting and melancholy evidence of the obstacles that yet exist to the free interchange of knowledge through the medium of print.

At the afternoon session, over which Mr. E. H. Lindgren presided, Mr. Colin Dean described the organisation of the Central Film Library, and during the session there were shown the films "Library of Congress" and "Book Bargain". The final session, when Dr. J. E. Holmstrom presided, was devoted to a discussion on technical dictionaries and glossaries, which was introduced by Miss M. Gossett.

RE-OPENING OF THE GEOLOGICAL MUSEUM, SOUTH KENSINGTON

THE Geological Museum at South Kensington was re-opened on September 18 after being closed for seven years. From 1935, when the new building in Exhibition Road was opened by the King, then Duke of York, until the outbreak of war, there were considerably more than a million visitors to the Museum, which is still the most modern and well-fitted of its kind in the world. Throughout the War the building was occupied by the headquarters staff of the London Civil Defence Region. The galleries were converted into offices; the more valuable exhibits were evacuated to North Wales, and the remainder were stored. Although a heavy bomb fell on the pavement near the main entrance, and another struck the Geological Survey and Museum offices at the west end of the building, no major structural damage was caused by enemy action; but a vast amount of repair and restoration work has been necessary, including some 15,000 sq. ft. of window and roof glazing.

The reconstruction of the exhibits has been taken in hand and has now proceeded far enough for the main hall to be re-opened to the public. Among the more striking permanent exhibits in this hall are the unique rotating relief globe 6 ft. in diameter coloured to show world geology—this most fortunately survived the explosion of a 1,000 lb. bomb about 50 ft. away; illuminated dioramas of past and present scenery; large relief-models of south-eastern England; many hundreds of photographic enlargements of geological subjects; and the Museum's collection of precious and ornamental stones. There are also three special exhibits of topical interest. The largest of these, "British War-time Geology", illustrates some of the contributions to the war effort made by British geologists in both the industrial and the military spheres.

The examples in the Museum of geological work carried out within the British Isles, which are demonstrated by maps, diagrams, photographs and specimens, include intensive survey and search for outcrop coal, for the ores of iron, lead, zinc, tungsten and tin, and for many other essential minerals such as mica, barytes, fluorspar and sand for the manufacture of optical glass; the survey and development of underground water-supplies for new factories, camps and aerodromes; and advisory work on the construction of underground factories, ammunition stores and other works.

Other parts of the display now available to the public deal with the application of geology to military operations overseas. Examples are shown of maps prepared by geologists during the planning of each major operation to predict the suitability of enemy-occupied territory for the passage of tanks, and for the rapid construction of airstrips, trenches and camp-sites. Other maps show the occurrence of rock for road and aerodrome construction and repair, and the prospects of obtaining underground water. There are examples of specially vital work on water supply in Egypt and the Western Desert. A related small exhibit of German military geological maps shows analogous work done by the enemy; of particular interest is an inch to the mile German map of the Brighton–Eastbourne district, revised to June 1940 in preparation for invasion, bearing notes on landing beaches, geology, topography and water-supply. A third special exhibit of current interest illustrates radioactive minerals from the principal producing localities throughout the world.

THE IRAVAS AND CULTURE CHANGE

THE Irava, who live on the Malabar coast, form a suitable subject for a study of culture change as they are a large and vigorous section of the Hindu community. Although not actually caste Hindus, neither do they belong entirely to the depressed classes, standing as they do at their head. Great changes have come over the life, social and economic, of the Irava since the British rule; and A. Aiyappan, himself a member of the tribe, is well qualified to record the culture changes wrought by the impact of the West on the Hindus (*Bull. Madras Gov. Mus.*, 1; 1944).

Starting with an explanation of his method, Dr. A. Aiyappan describes the setting of the problem, both geographical and historic, and the early political history of the district. There follows a most illuminating section dealing with the caste customs of the district and of the two million Irvanas in particular, fining it down to a certain village which he describes in great detail. He dwells at some length on untouchability, which may almost be said to reach its apotheosis in Malabar; the term is perhaps misleading and the expression 'contact taboo' is to be preferred.

The marriage customs and kinship systems of the Irvana form a most interesting chapter, the domestic life and in-law relationships being sympathetically described. In this caste the rather rare form of marriage, fraternal polyandry, used to be, and to some extent still is, practised, as many as five brothers being married to one wife.

Although the main occupation is the cultivation of coconut palms for the traditional occupation of toddy-making, there is also a good deal of agricultural labour, principally in the rice field. Toddy-tapping is a popular occupation as it only occupies a small portion of the day, although the palms need attention every day, and as a supplier of drinks the toddy drawer enjoys plenty of company. As is customary among Dravidian peoples, the Irvana women work in the fields with the men and are not secluded like those in the north of India. Food, houses and clothing are then described, in common with other economics, including the gains and losses due to culture contact. Further chapters on education, magic and religion, and law and order bring to a close this most interesting study.

On the whole, the author is optimistic regarding the future of this large tribe; he feels that culture contact may produce beneficial results, and is not unhopeful of the ultimate acceptance of the oppressed classes by the Hindus. K. RISHBETH

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, October 7

FARMERS' CLUB (at the Royal Empire Society Craven Street, London, W.C 2), at 2 30 p m.—Discussion on a paper entitled "Improvements of Hill and Marginal Farms", by Capt A. R. McDougal (to be opened by Mr Moses Griffith)

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C 2), at 5 p m —Mr C F Booth and Mr. J. L. Creighton: "Piezo-Electric Quartz and its Use in Telecommunications".

PHYSICAL SOCIETY (in the Lecture Theatre of the Royal Institution, Albemarle Street, London, W.1), at 5 15 p.m.—Prof. M L E Oliphant, F R S "Rutherford and the Modern World" (Rutherford Memorial Lecture)

Tuesday, October 8

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W 1), at 2.30 p m —Sir Arthur MacNalty, K.C.B.. "Sir Thomas More as Public Health Reformer".*

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 5 p m —Scientific Papers.

INSTITUTION OF CHEMICAL ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p.m.—Messrs D. G Murdoch and M Cuckney: "The Removal of Phenols from Gas Works Ammoniacal Liquor"

ROYAL SOCIETY OF MEDICINE, SECTION OF EXPERIMENTAL MEDICINE AND THERAPEUTICS (at 1 Wimpole Street, London, W 1), at 5 30 p m —Prof H P Himsworth "Protein Metabolism in Relation to Disease" (Presidential Address).

ILLUMINATING ENGINEERING SOCIETY (at the School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C 1), at 6 p m —Mr J S. Dow Presidential Address.

INSTITUTE OF FUEL (at Central Hall, Westminster, London, S.W.1), at 6 p m.—Sir James Chadwick, F.R S.: Melchett Lecture.

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at Burlington House, Piccadilly, London, W 1), at 6 30 p m.—Mr. N. J. L. Megson. "Recent Advances in Plastics" (Chairman's Address)

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 8 p.m —Prof. W. M. Smart. "John Couch Adams and the Discovery of Neptune" (Conversazione).

Wednesday, October 9

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p m —Prof Willis Jackson Inaugural Address as Chairman

ROYAL AERONAUTICAL SOCIETY (in the Lecture Hall of the Institution of Civil Engineers, Great George Street, London, S W.1), at 6 p m —Mr R Smelt "A Critical Review of German Research on High Speed Air Flow".

Thursday, October 10

SHEFFIELD METALLURGICAL ASSOCIATION, MODERN METHODS OF ANALYSIS GROUP (at the Metallurgical Club, 198 West Street, Sheffield 1), at 7 p m —Mr E J Vaughan "The Application of Absorptiometric Methods to Metallurgical Investigation".

Friday, October 11

TEXTILE INSTITUTE, LANCASHIRE SECTION (at the Textile Institute, Manchester), at 1 p m —Mr. J. W Howell "Scientific Lighting in Cotton Mills"

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Scientific Papers

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5 p m —Scientific Papers

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, University of Manchester, Oxford Road, Manchester, 13), at 5 p.m.—Discussion on "The Mathematical Training of Physicists" (opened by Prof E C Stoner, F.R.S).

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mr. R Scott. "Chemical Engineering in the Tar Industry"

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (joint meeting with the CARDIFF AND DISTRICT SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY and the SOUTH WALES SECTION OF THE SOCIETY OF CHEMICAL INDUSTRY) (at University College, Cathays Park, Cardiff), at 6 30 p m.—The subject will be Electrometric Analysis

INSTITUTE OF ECONOMIC ENGINEERING (at the Cowdray Hall, Henrietta Place, London, W 1), at 7 p.m —Prof Meyenberg: "My Visit to Germany—Investigation of Time Study and Motion Study Developments on the Continent".

TEXTILE INSTITUTE, DUBLIN BRANCH, at 7.30 p.m.—Mr. R S. Greenwood "Past, Present and Future Development of Rayon and Rayon Spun Fabrics".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHYSICS—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11 (October 10).

COUNTY HORTICULTURAL INSTRUCTOR; ASSISTANTS (two Women) for Lecturing and Demonstration Work, at Essex Institute of Agriculture, Writtle—The Chief Education Officer, County Offices, Chelmsford (October 12).

LECTURERS IN (i) MECHANICAL ENGINEERING, (ii) MATHEMATICS, and ENGINEERING WORKSHOP SUPERINTENDENT at Brighton Technical College—The Education Officer, Education Office, 54 Old Steine, Brighton 1 (October 12).

SENIOR ASSISTANT FOR ELECTRICAL ENGINEERING at the Municipal Technical College—The Chief Education Officer, West House, Halifax (October 14)

SENIOR BIOCHEMIST at the Teaching and Research Laboratory in the Maudsley Hospital Post-Graduate Medical School, Denmark Hill, London, S E 5—The Medical Officer of Health (B), Mental Health Services, County Hall, Westminster Bridge, London, S.E 1, quoting 2437 (October 14)

DESIGN ENGINEERS (5) (Ref C391); TECHNICAL ENGINEERS (2) (Ref C422); DESIGN ENGINEER (Ref. F597), for Directorate of Atomic Energy at Risley, near Warrington—Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C 2, quoting appropriate reference (October 15).

DEMONSTRATOR IN PHARMACOLOGY—The Dean, Guy's Hospital Medical School, London Bridge, London, S E 1 (October 19).

BROTHERTON RESEARCH LECTURER IN PHYSICAL CHEMISTRY in the Department of Textile Industries—The Registrar, University, Leeds 2 (October 21)

SENIOR RESEARCH OFFICER or RESEARCH OFFICER, for the Division of Forest Products, Melbourne, Vic, Australia—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W C 2, quoting appointment No 999 (October 26)

POST OF PRINCIPAL—The Secretary, Northampton Polytechnic, St. John Street, London, E C 1 (October 28).

HEAD OF A SMALL UNIT FOR THE DEVELOPMENT OF SPECIALIZED COMMUNICATIONS EQUIPMENT, near Farnborough, Hants—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1, quoting No. 1639 (October 30).

RESEARCH ASSISTANT FOR THE PHONETICS LABORATORY (with honours degree in either Physics or Electrical Engineering)—The Secretary, University College, Gower Street, London, W C.1 (October 31).

ASSISTANT LECTURER IN GEOLOGY—The Registrar, University College, Singleton Park, Swansea (November 2)

LECTURERS AND DEMONSTRATORS IN ENGINEERING (several)—The Secretary, Appointments Committee, Engineering Laboratory, Cambridge (November 4).

PRINCIPAL RESEARCH OFFICER and SENIOR RESEARCH OFFICERS (2) for the Physical Metallurgy Section of the Council for Scientific and Industrial Research, at the University, Melbourne, Vic, Australia—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W C 2, quoting appointment No. 998 (November 4)

PRINCIPAL RESEARCH OFFICER (PHYSICIST), for Section of Tribophysics, Melbourne, Vic, Australia—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W C 2, quoting appointment No 982 (November 4)

LECTURER IN BACTERIOLOGY—The Registrar, University, Manchester 13 (November 9)

APPOINTMENT TO THE TEACHING STAFF OF THE APPLIED OPTICS DEPARTMENT—The Secretary, Northampton Polytechnic, St John Street, London, E C 1

ASSISTANT CHEMIST—The Director, Experimental and Research Station, Cheshunt, Herts

ASSISTANT METALLURGIST—Staff Officer, B I C C, Belvedere, Kent, quoting S R 6

ASSISTANT MUNICIPAL ENGINEER for the Accra Town Council, Gold Coast—Crown Agents for the Colonies, 4 Millbank, London, S W 1, quoting M/N/12630

CHIEF ANALYST for London factory, CHIEF ANALYST for new factory in Poole, Dorset—The Production Manager, The British Drug Houses, Ltd., Graham Street, City Road, London, N.1

HEAD OF THE DEPARTMENT OF TEXTILE INDUSTRIES—The Principal, Technical College, Bradford

LECTURER IN CHEMISTRY—The Professor of Chemistry, University of Manitoba, Winnipeg, Canada (applications by air mail)

PHYSICIST—The Secretary, British Filters, Ltd, Old Court, Cox Green, Maidenhead, Berks

RESEARCH BIOCHEMIST—The Secretary, Liverpool Heart Hospital's Institute of Research for the Prevention of Disease, 117 Grove Street, Liverpool 7

SENIOR ASSISTANT IN THE DEPARTMENT OF PHYSICS, and LECTURERS in (i) MATHEMATICS, (ii) PHYSICS, (iii) CHEMISTRY, (iv) CHEMISTRY WITH BIOLOGY, (v) MECHANICAL ENGINEERING—Clerk to the Governors, Woolwich Polytechnic, London, S E 18

TEMPORARY ASSISTANT FOR THE DEPARTMENT OF MATHEMATICAL PHYSICS—Prof. P. P. Ewald, Queen's University, Belfast

HORTICULTURAL LECTURER AND MANAGER OF THE HORTICULTURAL DEPARTMENT at Farm Institute, Sparsholt, near Winchester—The County Education Officer, The Castle, Winchester

LECTURERS IN (i) STRUCTURAL ENGINEERING, (ii) MECHANICAL ENGINEERING at the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research: Water Pollution Research. Technical Paper No 9. Animal Life in Percolating Filters, Identification of Flies, Worms and some other Common Organisms. By T. G. Tomlinson Pp. iv + 19. (London: H M. Stationery Office, 1946) 9*d* net. [145

The Fishermen's Struggle against Pollution, with Special Reference to the River Trent By J I Spicer. Pp 28 (Nottingham Trent Fishery Board, 1946) 9*d* [145

Geological Survey of Great Britain England and Wales Wartime Pamphlet No 46 Barium Minerals in England and Wales. By Dr K C Dunham and H G Dines; with Contributions by T Eastwood, J. V. Stephens, Dr. S. E Hollingworth, W. Anderson and Dr J. R Earp Pp v + 150. (London Geological Survey and Museum, 1945.) 6*s* 9*d* [165

Other Countries

Bergens Museum. Årsberetning, 1943–44. Pp 84. Årsberetning, 1944–45 Pp. 91 (Bergen A.-S. John Griegs Boktrykkeri, 1944–1945.) [193

Bergens Museums Årbok, 1944. Hefte 1, Naturvitenskapelig rekke Pp 220. (Bergen: A.-S John Griegs Boktrykkeri, 1945) [193

Eclipse total de sol del 20 de Mayo de 1947: su desarrollo en el continente Sudamericano. Por Alfredo Völsch Pp. 62. (Córdoba Observatorio Nacional Argentino, 1946) [193

Annals of the New York Academy of Sciences Vol 46, Art 5 The Diffusion of Electrolytes and Macromolecules in Solution By L G Longsworth, Charles O Beckmann, Margaret M Bender, Edward M. Bevilacqua, Ellen B Bevilacqua, Douglas M French, A. R Gordon, Herbert S Harned, Lars Onsager, Jerome L. Rosenberg and J W Williams Pp 209–346 Vol 47, Art 1 The Golgi Apparatus an Interpretation of its Structure and Significance. By Leonard G Worley. Pp 56 (New York New York Academy of Sciences, 1945–1946) [193

Annual Report of the Indian Central Jute Committee for the Year 1944–45 Pp ii+171 (Calcutta: Indian Central Jute Committee, 1945) [193

Slovenska Akademija Znanosti in Umetnosti v Ljubljana: Matematično-prirodoslovni razred Dela 3. Turbelarijska teorija knidarijev By Jovan Hadži. Pp 240. (Ljubljana: Slovenska Akademija Znanosti in Umetnosti, 1944.) [193

Nigeria Annual Report on the Forest Administration of Nigeria for the Period 1st January 1944 to 31st March 1945. Pp 47 (Lagos Government Printer, London: Crown Agents for the Colonies, 1945) 4*s*. [213

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 97, 1945 Pp. iii+287+30 plates. (Philadelphia: Academy of Natural Sciences, 1945) 7.50 dollars. [253

U.S. Department of Agriculture. Technical Bulletin No 905: Biology and Control of the American Dog Tick By Carroll N. Smith, Moses M. Cole and Harry K. Gouck Pp 74 (Washington, D.C.: Government Printing Office, 1946.) 20 cents. [253

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LEADERSHIP AND INCENTIVES IN INDUSTRY

THE attention which has in recent months been focused on management, as shown, for example, in the formation of the Administrative Staff College, of which Mr. Noel F. Hall has recently been appointed principal, in the recommendations of the Percy Committee on Higher Technological Education regarding training for management, and in the proposals of the Baillieu Committee for the establishment of a British Institute of Management, has sprung from two main roots. First, there is wider recognition of the importance of a higher standard of management if we are to increase the technical efficiency of British industry and to secure the best use of our resources of man-power and woman-power. This approach is emphasized, for example, in the report of the Working Party for the Cotton Industry which, welcoming the formation of an Administrative Staff College, urged also that the central body for the industry should direct attention to arrangements for providing instruction in the principles of management. The second factor is the realization of the important contribution of management in establishing the right relations and co-operation on which industrial efficiency depends, particularly in the changed social conditions of a state of full employment.

Both these factors are discussed by Colonel L. Urwick in a stimulating paper, "Administration and Leadership", contributed to a recent issue of the *British Management Review*, and they are reflected in a series of monographs on higher management which are being published by the Department of Industrial Administration of the Manchester Municipal College of Technology. These monographs are the outcome of a conference of industrialists in the Manchester area during May 1945, which resulted in a course of four lectures for senior executives, the first of which was delivered by Colonel L. Urwick on "Patterns of Organisation", the subsequent ones being by Sir Arthur Fleming on "The Impact of Science on Industry", Mr. T. G. Rose on "The Mensuration of Management", and Mr. C. G. Renold on "The Employer and the Social Fabric". It is also intended to include in the series reports and pieces of research work undertaken by the staff of the Department and its senior research students. The monographs thus represent a definite step towards providing the instruction in the principles of management suggested by the Cotton Working Party in its report and also towards encouraging the research on matters affecting industrial employment which the Working Party likewise recommended.

Colonel Urwick, in the paper first mentioned, maintains that administration and leadership are the two principal functions of those whose responsibility it is to govern, or participate in the government of, social groups. By administration he understands the aspect of management or government which is concerned with the activities of forecasting, planning, organising, commanding, co-ordinating and controlling the work of the group, whereas leadership is

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concerned with the personal, human, dynamic aspect of the total task of government, which renders such aspects an art rather than a science. Further, he believes that the central industrial problem of our time is how to present the purposes of our co-operative systems of an executive character so that they gain and retain the willing, spontaneous co-operation of those who do not participate and cannot participate in determining those purposes. Pure administration is not enough, nor is trying to imitate the processes of political democracy, and accordingly he maintains that the most important subject for industrialists to study to-day is leadership.

Colonel Urwick expounds Mr. Ordway Tead's definition of leadership as winning the will to co-operate from those whose co-operation is needed, and making the purposes of the joint undertaking explicit and continuously attractive to those who share the burden of attaining them. The core of sound human relations in any form of organised endeavour lies in the identity of the individual with the purposes of the group, opportunity for the individual to grow within the group and equity in the treatment of the individual by the group. Colonel Urwick, stressing that every business must have a social purpose, suggests that British employers are missing an opportunity for leadership in this direction. Unless the leader is convinced of the rightness of the cause, he cannot convey that conviction to others, and these are the essential conditions if he is to represent the group he leads.

Next among the functions of leadership, Colonel Urwick places initiative; third comes administration—a complementary part of the process of government—and finally the function of interpretation, which joins hands with the initiative function and is of vital importance in the task of education and the creative settlement of dispute. It is only through personal leadership of this type that he thinks it is possible to satisfy the aspirations towards a more democratic spirit in the ordering of our systems of co-operation for executive purposes; and he concludes by emphasizing the importance in facing the difficulties in the transition from war to peace of an adequate supply of leaders at all levels. That involves four things: the arrangement of our organisations so that the opportunity for, and the responsibility of, clear-cut executive leadership are obvious at every level; the utmost care in selecting future leaders; use of equal care in developing subordinate leaders; and perfecting and expanding our arrangements for the formal training of leaders. It is probably in the last respect that we are weakest. Much can be done to develop the natural qualities of a potential leader by systematic study, and Colonel Urwick urges that we need a national staff college for industry, comparable with the Staff College at Camberley. Strong executive leadership, he maintains, is essential to democratic government to-day—in industry no less than in politics.

The bearing of Colonel Urwick's remarks on the current situation is even more apparent in the emphasis which he places on the separation of the policy-making or planning level from the operational or executive level. The distinction is vital if we are to avoid either endless confusion as to what is involved in the nationalization of industry, or hopelessly to prejudice the work of the joint industrial councils or other means of securing the common outlook and co-operation upon which industrial and social efficiency alike depend. Both Colonel Urwick and Mr. Renold drive home this same point in their lectures in the series of monographs on management. "It is not government which is inefficient," Colonel Urwick points out, "but forms of organisation which fail to distinguish between planning and performance, between political and administrative processes"; and he proceeds to emphasize both the inefficiency which results from a board of directors muddling executive management instead of sticking to policy, and the dangers which lie in the tendency for the spheres of political and business leadership to become more and more intermingled.

But there is much else in this lecture which provides food for thought at the present time. Quoting the considered opinion of Lilienthal that, in creating the Tennessee Valley Authority, "Congress adopted and wrote carefully into law the basic principles and practices of modern management", Colonel Urwick notes that the common weakness in such public corporations is failure to provide for adequate executive leadership of the group as a whole. Using his study and experience of military organisation, Colonel Urwick here develops ideas which are as pertinent to industrial organisation as to the regional organisations which we must now contemplate in the development of health services and the reorganisation of local government in Britain.

It is, in fact, in this second part of his lecture, in which after discussing the unit he turns to what he calls the formation, that Colonel Urwick is most suggestive and stimulating. Insisting on the vital importance of a proper balance and integration of theory and practice, he argues trenchantly for the new staff college for industry, and suggests that if its graduates are not successful when they go into industry, then the blame may well be the shortsightedness of business leaders who refused to devote sufficient time for the purpose. He would prefer to start with few students and little publicity, relying on the effect of turning out a first-class product as the result of the first two or three courses.

Colonel Urwick does not forget that business can offer few positions comparable with that of the staff officer in the Services, but he remarks pertinently that it is only by taking thought that any man can add to his administrative stature; and his observations on the concealed losses of human quality due to mechanical supervision and lack of imagination and critical thinking are much to the point. Similarly, in the first part of his lecture, he stresses the biological analogies in discussing human systems of co-operation, and his enunciation of the principles of organisation and of the methods of grouping activities whether by kinds or by levels of authority and responsibility, keeps this aspect clearly in mind; similarly, he picks out the critical points in the normal development of an economic undertaking from small beginnings as a one-man affair. The scalar principle, the principles of specialization, of correspondence of authority and responsibility, and of the span of control, are expounded as clearly as in his earlier writings; and in pointing out the dangers which attend the growth of any undertaking, Colonel Urwick gives clear guidance as to the ways in which these dangers can be avoided, and new and appropriate patterns of organisation developed.

Mr. Renold's approach to his subject is of a different order but no less suggestive. Mankind, he holds, has struck its tents and is seeking new pastures, a new mode of life, a new world; and in reviewing some of the changing features in our industrial system, he stresses first the emergence and general acceptance of the conception that the industrial worker has citizen rights in industry. Such rights must clearly be associated with duties; but Mr. Renold points out, though less lucidly than Colonel Urwick, that the analogy between the political and the industrial field breaks down at the executive level. Unless there is agreement on common objectives, the claim that employees should participate with employers in the appointment of management officials becomes farcical.

Mr. Renold stresses the importance of seeking objectives in industry which are acceptable to the public, the workers and the owners, and meanwhile he points out that it is quite practicable to reach agreement between management and representatives of the various grades of employees on what may be termed domestic law, such as the works rules, terms of employment and the like. Administration is a different question, and because of its repercussions on efficient administration and particularly in team-building, he questions the practicability of an independent judiciary for breaches of domestic law. The problem is, of course, part of the difficult one of building up general morale, and becomes less acute as we succeed in finding common objectives, and Mr. Renold has much to say about the development of new loyalties, which he ranks high among the duties forming the counterpart of rights in the conception of industrial citizenship.

Something much more than profit-sharing or co-partnership is required: it is fundamentally the question of arousing interest in a man's daily work. A common objective, a conviction on the part of each member that he has a personal contribution to make, and the knowledge that his contribution is recognized: these are essential conditions for successful team-building and the inherent loyalty it implies. Mr. Renold suggests that the Training within Industry Scheme offers possibilities in this connexion, but commenting on the extreme complexity and close integration that now characterize economic life, he believes that a national wage policy is also essential. The settlement of wage disputes can no longer be left to the process of collective bargaining, because the community as a whole has just as vital a stake in the outcome as the parties themselves. In this he is in agreement with Prof. H. S. Kirkaldy, who insisted in his inaugural lecture at Cambridge that this is one of our most urgent needs. Finally, he points to the growing acceptance of the idea of a social purpose in industry, and suggests that the general set-up of industry should be such as to provide a soil in which the spirit of service can grow, and that the conduct of industry should be such as to cultivate that growth. Nationalization, he believes, may provide an answer to the institutional or formal aspect, but is liable to fail in regard to conduct or leadership, and he suggests that both the forms of industry and the leadership must be modified.

Mr. Renold may be too confident of the ability of private enterprise to provide the leadership that is required. Given the training and the sense of common purpose, leaders of the right calibre would probably be thrown up in similar proportions by public or private enterprise: the emphasis comes on enterprise and initiative, and the form of organisation must be such as to promote these. But this lecture, and those of Colonel Urwick, are a challenge and a stimulus to constructive and creative thinking on both the forms and the practice of management, and they reinforce all those arguments which have been advanced in the report of the Baillieu Committee, the report of the Percy Committee on Higher Technological Education, and in those of the Working Parties for the Cotton Industry, the Boot and Shoe Industry and the Pottery Industry, for greater attention to this question of the quality of management and the closer investigation of the many factors that affect the health, efficiency and interest of the workers.

The monographs which the Department of Industrial Administration of the Manchester College of Technology has thus initiated are both a useful contribution to the literature of industrial management in Great Britain, the quality of which was adversely criticized by the Percy Committee, and also a welcome indication of the increasing extent to which the nation is prepared to support the newly established Administrative Staff College and the British Institute of Management. The Department's activities hold promise of a solid contribution to the work of building up a new structure in industry which will satisfy alike the demands for increased mechanical efficiency and the human needs and social purposes of an era of full employment. The Tavistock Institute of Human Relations is also breaking fresh ground in setting itself the task of finding out more about the underlying psychological factors in social relationships such as industrial groups, and removing some of the obscurity which clouds human motivation. Lord McGowan has testified to the discipline, the desire to work and the greater sense of responsibility observed in those returning from the Services to work in the great firm of which he is chairman, and he has referred also to the urgent need for industrialists to make an intensive effort to break down fears of unemployment, to uproot suspicion and to arouse interest in efficiency and production.

Much more time must indeed be devoted by management to explaining the problems and operations of industry to the employees, and the proposals for the training of managers and administrators will not by themselves suffice. There must be a simultaneous effort to provide the technical training in management that is required at lower levels; for example, at what may be termed the 'non-commissioned officer' or foreman level of industry. More than good personnel management, however, is essential if effective incentives, and especially the social incentive, are to be developed in industry. Simultaneously, research must proceed into operating conditions and problems of human relations, so that the trained managers at every level may have fuller facts at their command in reaching decisions and framing or executing policy. Above all, there must be enlisted the interest and co-operation of the trade unions themselves, both in the selection and training of men and in the research into human and operating problems, in order that we may build up the sense of common purpose, the understanding and good will which form the basis of morale in industry as elsewhere. The achievement of such an end demands also open mindedness and the readiness to discard prejudices, obsolete forms and practices, no less on the side of the workers than of management, and for their contribution to that end alone these monographs deserve a warm welcome.

THE LEPIDOPTERA OF SWEDEN

Svenska Fjärilar

Systematik bearbetning av Sveriges Storfjarılar, Macrolepidoptera. Av Frithiof Nordström och Einar Wahlgren. Pp. iv+86+354+50 plates. (Stockholm: Nordisk Familjeboks Forlags A.-B., 1941.) 115 kr.

THIS splendidly printed and illustrated monograph, although bearing the date 1941, has only recently come to hand. It is under the general editorship of the well-known entomologist, Albert Tullgren, who contributes an introduction. Being of quarto size, a very large amount of information is provided in its 440 pages, and nearly every species of the Swedish Macrolepidoptera is figured in its fifty coloured plates. The so-called Microlepidoptera are left for future treatment. The monograph is divided into two parts which, for some reason or other, have separate pagination. Part 1 is devoted to general structure, habits, protective resemblance, distribution, etc., together with keys to the various families. It also contains a general bibliography of a limited kind; and runs to eighty-six pages with sixty-six text-figures and twelve distributional maps. In the latter, the range of each of the species shown is indicated by individual dots representing each locality, as has been done in E. B. Ford's recent volume on "British Butterflies". Part 2 constitutes the bulk of the monograph, and in its 354 pages (the subject-matter of which is arranged in double columns) will be found the essential information regarding the Swedish species, their range of distribution in that country, the larvæ and their food-plants. Some 369 text-figures portray genitalic characters and those features shown by the caudal extremity in great numbers of the pupæ. The coloured plates are of general all-round excellence: they are chromolithographs that give an accurate life-like representation of the adult insects and many of their larvæ. We do not recollect having seen finer coloured plates of their kind illustrating Lepidoptera, notwithstanding the large number of works that have been published on this order of insects.

Beginning with the butterflies, these are divided into Rhopalocera and Grypocera. It is interesting to note that *Papilio machaon* ranges over the greater part of the country and that *Lycæna arion* is widely distributed over the southern half. The distribution of the various species of Lepidoptera, it may be added, is indicated by laens or districts (except in the twelve maps already alluded to). Apparently neither *Apatura iris* nor *Limenitis camilla* is found in Sweden; but the handsome *L. populi*, on the other hand, ranges over most of the southern half of the country besides being found in the islands of Öland and Gottland. Among species with a restricted range is *Polyommatus hylas*, which is confined to Malmohus and Blekinge, together with the two larger islands just mentioned. Among the Vanessinæ, the genus *Brenthis* with nine species is well represented. One species, *B. frigga*, has a wide range north of Stockholm. Altogether some 108 species of butterflies are included as being Swedish. This relatively high number is partly accounted for owing to the arctic element in the fauna being well represented.

Among the moths, the account begins with the Sphinges, which include the same species as those found in Britain. The Notodontidæ include our British species along with several others such as *Notodonta phœbe*. It is interesting to learn that *Leucodonta bicoloria*, so rare in the British Isles, is widely distributed in southern Sweden. The Lasiocampidæ and Lymantriidæ comprise all the British members, together with such striking species as *Dendrolinus pini* in the first-named family and *Dasychira abietis* in the latter. The Noctuidæ are very well treated. The genus *Catocola* has no fewer than seven Swedish representatives and, among them, *C. fraxini* seems to have the widest range. In addition to the last-named there are a number of other species that have but a casual or very localized foothold in Britain and a very extensive distribution in Sweden. Notable instances are *Athetis* (*Hydrilla*) *palustris* and *Zygæna meliloti*. The Arctiidæ are very well represented in the Swedish fauna by a number of striking members, including *Rhyparia purpurata*, *Hyphoraia alpina* and *H. festiva*, that do not range into Britain. The usual British Hepialidæ (here spelled Hepiolidæ) occur together with the local *Hepialus* (*Hepiolus*) *canna*. The Zygænidæ have nine species and the Aegeriidæ (or Sesiidæ) fourteen, while the Psychidæ also comprise fourteen species and the Talæporiidæ four. The last-named family follows the Psychidæ and is not regarded, therefore, as belonging to the Tineidæ as some authorities believe.

A well-worked group of insects such as the Macrolepidoptera affords admirable material for faunistic comparisons. In this connexion the present work is invaluable since it provides the relevant data in a concise form. While the majority of British Lepidoptera range into Sweden, the richer fauna of the latter country contains many species that are not to be found in Britain. Except for the handicap of being written in the Swedish language, British lepidopterists could adopt this volume as a general work of reference. For many, the plates alone would prove of great assistance for purposes of general identification aided by such a work as that of Meyrick. The nomenclature used does not agree in many cases with that adopted in the latest British list by Kloet and Hincks. It follows, in general, a less heterodox and more usual system. Sufficient synonymy is quoted to avoid confusion, and it is outside the scope of this notice to cavil at differences of nomenclature. We extend congratulations to all concerned in the production of this volume, that will prove an admirable reference book both for the naturalist and the collector.

A. D. IMMS

NATURE IN THE FIELD

Fisherman Naturalist

By Anthony Buxton. Pp. 190+39 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1946.) 10*s*. 6*d*. net.

ANTHONY BUXTON, already well known because of his book, "Sporting Intervals at Geneva", has in his "Fisherman Naturalist" produced one of the best Nature books in recent times. One of the charms of this book is that the author writes entirely from his personal experiences—and they have been wide and varied. The first section of the book is devoted to fishing; the second to natural history. From his observations on the habits of birds, particularly the birds of his native county of Norfolk, Anthony Buxton shows that he is one of the best naturalists of the day, and he is able to describe his experiences in a vivid style that always holds the reader's attention. The photographs are very fine. We gather that some, but not all, have been taken by the author; perhaps in a subsequent edition of the book we may be told who was responsible for the others, for a fine photograph of bird or beast gains value and interest when it is known who has taken it.

The author has fished for brown trout, sea-trout and salmon in England, in Scotland and in Norway. He mentions that in Norway the best 'taking' wind for salmon is in the north-west, and I think that this holds good on Scottish rivers. Trout at times do interesting things. I quote from p. 38: "Once, on the Itchen at St. Cross, while fishing in a private garden through which one branch of the river ran, I saw a trout lying by the side of a water-lily leaf. My fly landed on the surface of the leaf, but the trout saw it land, poked its head over the top of the leaf, and picked it up."

The author on one occasion when fishing Loch Airienas in Morvern found many bumble bees lying on the still surface of the loch, and has little doubt that they were struck down by dragon flies. "I have no doubt [p. 58] that the bees on the water were runners which the dragon flies had knocked down but had not bothered or dared to pick up."

Mr. Buxton devotes one chapter to "Terriers at Fishing and other Sport". His terrier "Jane" is an expert at retrieving fish from the water, and this reminds me that a collie we once had was also a very keen fisherwoman. "Dileas" (Faithful) used to be most excited if a salmon rose in a pool which I was fishing. She twice landed a salmon. On one occasion when a Hebridean river was low, a salmon, disturbed by my appearance at a pool, left it and started down the stream for the sea, which was near. "Dileas" entered the river and brought out the salmon, one of 12 lb., clean run. On another occasion she took a salmon from the spawning beds, and when I returned the fish to the water she rushed in and brought it again to the bank; it required much persuasion to prevent her entering the water for a third time.

Chapter 5 describes a sea flood in Norfolk. This took place in the year 1938, when the sea covered an area of 7,500 acres for three months. The sea at once killed all freshwater fish in the meres and streams of this area, except eels, which flourished in the sea water. A crab was seen walking across a ploughed field, and herring, grey mullet, sprats and shrimps replaced the freshwater fish. Barnacles grew on the stems of reeds. All trees, grasses and bushes were killed. But daffodil bulbs survived (p. 109), although they remained dormant for eight years. Ash trees were killed at once, and oaks also died, but young birch (p. 112) suffered no ill-effect after three months submersion. Many birds deserted the affected area or did not nest, but yellow wagtails increased tenfold.

Mr. Buxton has made extensive observations of the Norfolk harriers from a hide. He states that the pairs of Montagu's harriers which he watched varied greatly, both in beauty of plumage and in temperament. One pair came to recognize the author and had little fear of him. There are valuable notes on the hatching of the chicks. One chick received its first meal (p. 132) only twenty minutes after birth. The photograph of the mother harrier sheltering the young with outspread wings from the sun reminds me of a similar action on the part of a female golden eagle who very gradually opened her great wings until they were fully extended, and stood thus screening her eaglet from the sun's rays.

Mr. Buxton relates that in a marsh harrier's nest (p. 138) the young birds slew and ate two weaklings of the brood. I believe that when one young golden eagle attacks and kills the other, as it often does, it may sometimes devour the victim of this unprovoked aggression. Mr. Buxton is leniently disposed towards the harriers, although they do at times take young partridges. His remarks on so-called 'vermin' (p. 149) are worth quoting: "It is a view commonly held, that if vermin is not destroyed there will be no game or other birds. Those who have travelled abroad in countries where no gamekeepers, in our sense of the word, exist, must have realised that this view is not correct. Of course the destruction by birds and beasts of prey is considerable but there is really enough for all to eat, and if there is any shortage the birds and beasts of prey betake themselves to where there is plenty."

One of the most interesting chapters in the book is that describing the courting of blackgame. A prolonged watch, extending for weeks during the nesting season, was kept from a hide near a fighting ground in Morvern, and new and valuable information on the habits of the birds gathered. The author mentions that the blackgame there have decreased: in Mull, only a few miles distant, from being numerous in 1915 they have now become almost extinct. I am glad to see that the author (p. 93) does almost all his bird watching with a telescope, as I do the same thing. It is harder to use, but I think gives a better view, at all events of larger birds, although for small birds of quick movement binoculars are preferable—but one must choose between one and the other, and a telescope is my preference

This book is so full of good things that the reviewer is tempted to go on indefinitely. It is obviously written by one who has a deep love for Nature.

SETON GORDON

THE ENIAC, AN ELECTRONIC COMPUTING MACHINE

By Prof. D. R. HARTREE, F.R.S.
University of Manchester

Introduction

ENIAC (Electronic Numerical Integrator and Computor) is the name given to a large general-purpose calculating machine, operating by the counting of electrical pulses by electronic counting circuits, which has recently been built at the Moore School of Electrical Engineering of the University of Pennsylvania, Philadelphia. It was devised by Dr. J. Presper Eckert and Dr. John Mauchly, then of the Moore School, and was developed for the Ballistics Research Laboratory at Aberdeen Proving Ground, this development being sponsored by the U.S. War Department on the initiative of Colonel Paul N. Gillon of the Office of the Chief of Ordnance; Dr. (then Capt.) Herman H. Goldstein was closely associated with the development of the machine as representative of the Ordnance Department at the Moore School. A short article on this machine has already appeared in *Nature* (April 20, p. 527). I have recently returned from a visit to the United States in the course of which I had the privilege of working with this machine, and this fuller account is based on this experience.

Two Main Classes of Computing Equipment

Computing equipment can be divided into two main classes. Devices of one class operate by translating numbers into physical quantities (for example, lengths, angular rotations, voltages, light fluxes) of which the numbers are the measures, operating with these quantities (such as with angular rotations through gear trains, with voltages through electrical circuits) and finally measuring some physical quantity to obtain the answer; examples are the slide rule, the differential analyser[1] and the heat flow computor of Beuken and of Paschkis and Baker[2]. Those of the other class handle numbers directly in digital form and, usually, operate by counting discrete events of some kind; examples are the ordinary desk calculating machines such as the Brunsviga, Marchant and Fridén. I have found it convenient to distinguish the two classes by the terms 'instruments' and 'machines' respectively; the American usage is 'analogue' and 'digital' machines.

Devices of the former class may be able to handle continuously varying quantities, but their accuracy is limited by the attainable accuracy of physical measurement, and of the mechanical and electrical components of which they are built up. Devices of the second class are necessarily restricted to handling numbers which can be expressed in finite digital form; thus they cannot directly handle continuously varying quantities but, with that restriction, they can in principle be built to work to any required finite degree of accuracy.

The ENIAC is of the second class. It carries out by electronic circuits the processes of arithmetic, of which discrimination of the sign of a number and judgment of the equality of two numbers must be added to the usually recognized processes of addition, subtraction, multiplication, and division. Integration has to be replaced, as is usual in numerical work, by summation over a finite number of finite intervals. The machine was built primarily for integration of the equations of external ballistics by such a step-by-step process; but its organisation is flexible enough for it to be applicable to a wide range of large-scale computations other than numerical integration of differential equations.

Arithmetical Processes, 'Memory', and Organisation

The purpose of the ENIAC is to carry out extended computation automatically, or with only occasional attention from a human operator. Both for this reason and to make full use of the high speed at which the machine carries out individual arithmetical operations, it is necessary first that the sequence of individual operations should be furnished to the machine in such a form that it can be followed automatically, and at a speed comparable with the speed of carrying out individual arithmetical operations; and secondly, that the machine should be able to record and retain intermediate results of the calculation in such a form that they can be both recorded and read in times comparable with the times occupied by arithmetical processes.

Thus, as well as equipment for carrying out the arithmetical operations, the machine requires a means of organising the sequence of these operations, and a 'memory' for the numbers on which these operations are to be performed and for the results of these operations. These two aspects of a large high-speed calculating machine are at least as important as the means of carrying out the arithmetical processes themselves. The range of computing problems to which a machine of this kind can be effectively applied depends critically on the high-speed memory capacity which the machine provides, and one of the problems for future general-purpose machines is to provide adequate capacity without requiring excessive amounts of equipment.

General Construction of the ENIAC

The ENIAC consists of a number of units for carrying out the various operations which may be required in an extended computing problem, such as addition, multiplication, division, input (that is, reception of numerical data from the outside world), output (that is, provision of numerical results to the outside world) and organisation of the sequence of the computation. Interconnexions between these units can be set up in different ways through plug-and-socket connexions and switch settings, and these connexions and settings, which are made by hand, form the 'set-up' of the machine for any particular computation.

Each unit consists of an assembly of electronic valves, switches, relays, indicating lamps, and plug sockets, mounted on one or more panels about 8 ft. high and 2 ft. wide and permanently connected with the switches, indicating lamps, and plug sockets in front and the valves, relays, and associated equipment at the back. There are altogether forty of these panels arranged around three sides of a room; Fig. 1 shows a general view of the machine, Fig. 2 a closer view of the front of the first six panels on the left-hand side of Fig. 1, and Fig. 3 a close-up view of the front of two adjacent panels.

The various units are interconnected through two sets of coaxial lines carried in 'trays' running round the length of the machine, one set (*a* in Figs. 2 and 3) called 'digit trays' for carrying pulse groups representing numerical data from one unit to another, and

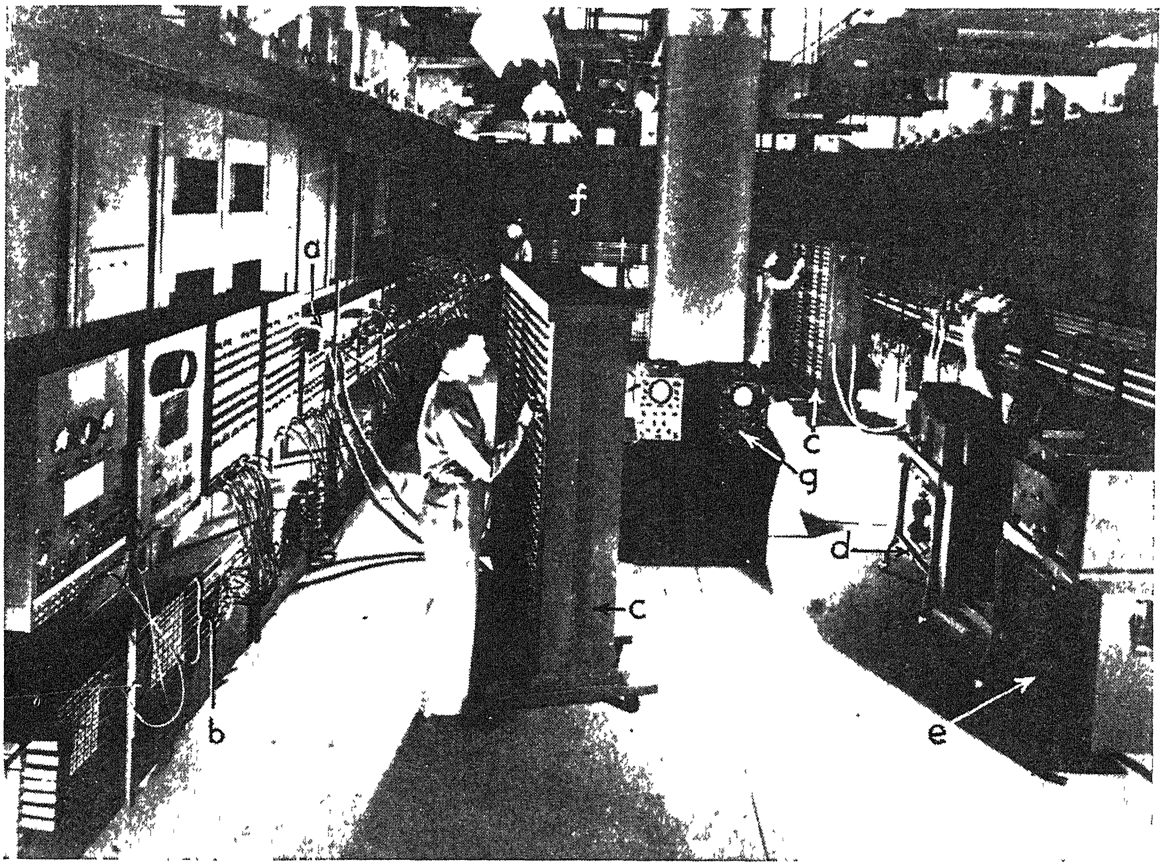

Fig. 1 GENERAL VIEW OF THE ENIAC. *a*, DIGIT TRAYS (SEE FIG 2), *b*, PROGRAM TRAYS (SEE FIG. 2), *c*, FUNCTION UNIT (SEE FIG 2), *d*, CARD READER, *e*, CARD PUNCH, *f*, HIGH-SPEED MULTIPLIER, *g*, TESTING EQUIPMENT

the other (*b* in Figs. 2 and 3) called 'program trays' for carrying pulses controlling the sequence of operations of the different units, which can be plugged into the trays in accordance with the set-up for any particular computation. The units are also permanently connected to a set of lines which are supplied with a standard pattern of pulses from a pulse-generator. Individual pulses used for numerical purposes are spaced at 10 microsec. interval, and the whole pattern of pulses is repeated every 200 microsec.; this is the time taken to carry out an addition on the machine, and is the natural unit of time in which to express its performance; it is called an 'addition time'.

The machine works with numbers expressed in the decimal scale, to ten decimal digits, and with each number there is also an indication of its sign. Pulse groups representing the digits of a single number are transmitted simultaneously on different lines, requiring eleven lines in each digit tray for the ten decimal digits and sign (the twelfth terminal, which can be seen in Fig. 3 on the digit tray sockets, is for an earth connexion).

The 'program trays' have the same construction as the digit trays, but in their use each line is used independently of the others, so that a single tray carries eleven distinct 'program lines' for the transmission of pulses controlling the operation of the various units.

In the counting and control circuits, all valves are used entirely as on-off elements, not as amplitude-sensitive elements, and the circuits have been designed to operate satisfactorily with wide tolerances on valve characteristics, applied potentials, pulse frequency, etc. To avoid replacement difficulties only standard valves are used, and these are run at conservative ratings

Accumulators

The basic units of the ENIAC are the 'accumulators' (see Fig. 3), each of which is analogous to a register of a multi-register adding machine such as the "National", and combines the functions of an adding unit and a memory unit.

The numerical portion of each accumulator consists of ten decade counters, one for each decimal place, a decade counter consisting of ten double-triode valves in a ring. Each of these valves has a 'normal' and an 'excited' state, and the connexions of the counting ring are such that at any time only one valve of the ring is in the excited state, and that the reception of a single pulse steps the excitation from one valve of the ring to the next. There are auxiliary valves for controlling carry-over from one decade to the next, for transmission of the number represented by the excited valve in each decade, for clearing, etc. Transmission is effected by cycling each decade by supplying it with ten pulses, carry-over from one decade to the next being suppressed; if the excited valve in a decade represents the number n, then either n or $9-n$ of the ten pulses can be transmitted, depending on the setting of a switch; thus either a number held in an accumulator or its complement can be transmitted. The counting rings count only

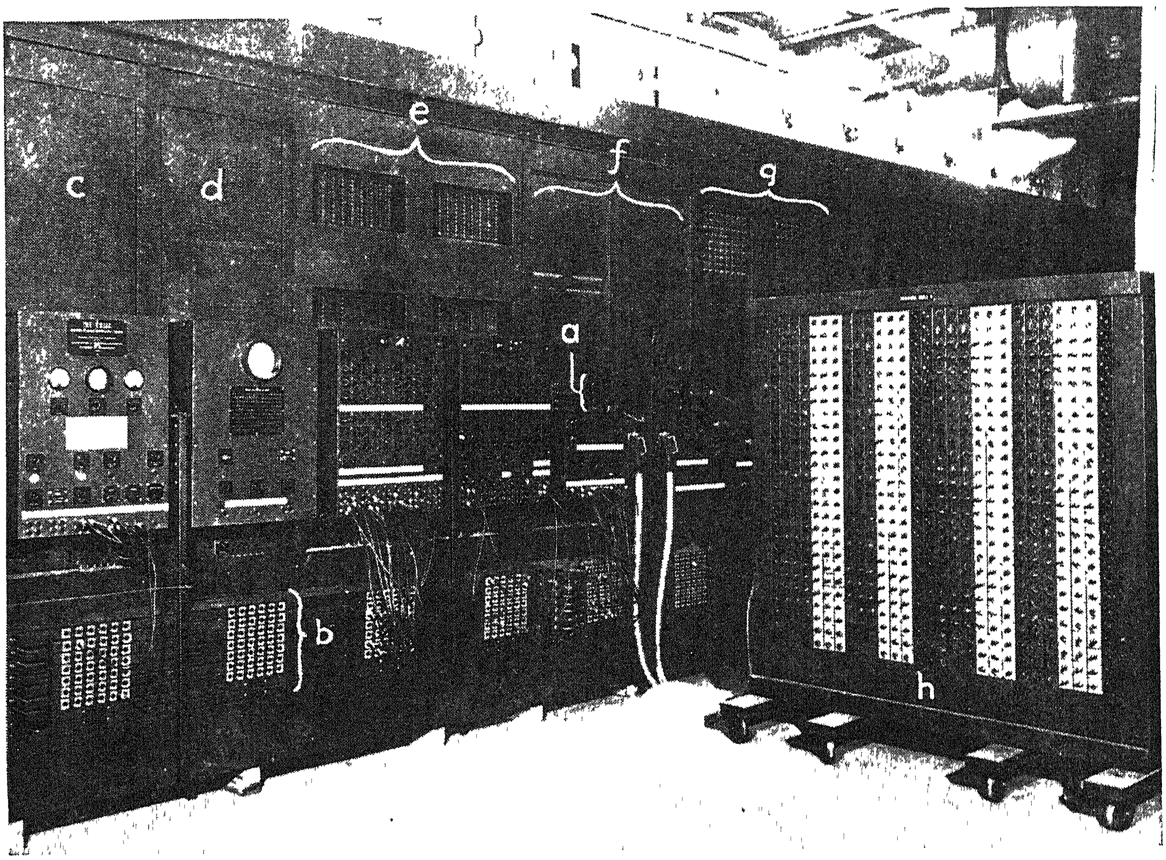

Fig. 2. Left-hand side of the ENIAC *a*, digit trays ; *b*, program trays , *c*, initiating unit panel (initiating pulse, controls for card reader and card punch) , *d*, pulse generator panel ; *e*, master programmer panels ; *f*, panels for function table (*h*) ; *g*, panels of accumulators 1 and 2 ; *h*, function table

in one direction, and subtraction is effected by addition of the complement. The number held by an accumulator, that is, the number represented by the excited valves in its ten decades and sign register, is indicated on the front of the panel by means of indicating lamps (Fig. 3, *e*).

Each accumulator has two channels for the transmission and five for the reception of numerical information ; each of these channels can be connected to any digit tray by plugging in a short length of 12-wire cable to sockets on the accumulator and digit tray (see Fig. 3, *f*). On one of the transmission channels the accumulator can transmit the number it holds (additive output), and on the other the complement of this number (subtractive output) ; these can be used simultaneously, but if so must be connected to different digit trays. In the connexion from a digit tray to a reception channel there can be interposed a 'shifter' by which the p-th decade from the right in the transmitting accumulator is connected to the $(p + n)$-th decade in the receiving accumulator ; shifters with connexions giving various positive and negative values of n are available, and serve for multiplication by powers of 10. Through its five reception channels an accumulator can be connected to different digit trays, or to a single digit tray both directly and through one or more shifters. Only one reception channel can be used at once.

The normal state of an accumulator is quiescent, holding the number which resulted from its last operation. It has twelve program channels through which it can be stimulated by a pulse from a program line, this pulse being transmitted by one of the units involved in the next previous operation in the computing sequence, as soon as this operation is completed. What the accumulator does when so stimulated, that is whether it transmits additively or subtractively or both, and holds or clears after transmission, or receives, and if so on which channel, is determined by the settings of switches, of which there are two for each program channel on each accumulator (see Fig 3, *c*). Further, on eight of the program channels there are repeat switches (see Fig. 3, *d*), by which the accumulator can be set to repeat the operation of transmitting or receiving any number of times from 1 to 9. On each of these same eight program channels, the accumulator can transmit a pulse to a program line when the complete operation (including any repeats) indicated by the switch settings is completed. This pulse then stimulates the units concerned in the next operation of the computing sequence.

In the transfer of a number from one accumulator to one or more others, both or all accumulators involved, and no others, have to be stimulated simultaneously ; this is done by connecting one input program channel on each of the accumulators concerned, and no others, to a single program line. Since neither transmission nor reception can take place unless stimulated by a program pulse, a number of transmission and reception channels from a number of accumulators can be connected to the same digit tray, which will be concerned at different times with transfers between different members of this set of accumulators, those involved at any time being determined by the connexions to the program lines. On the other hand, simultaneous transfers can take place by connexions through different digit trays.

Multiplier

Multiplication by small integers (1 to 9) can be carried out by repeated addition by use of repeat switches, provided the values of these multipliers is known before the calculation is started. But for multiplication by numbers of several digits the process of successive addition is a long one, and multiplication is so frequent an operation in most computations that a quicker means of carrying it out is desirable.

The ENIAC has a high-speed multiplying unit which uses an array of electronic valves so connected as to form a built-in multiplication table up to 9×9; using this, the result of the multiplication of the whole multiplicand by each digit of the multiplier is carried out in one addition time. The left-hand and right-hand figures of each product of a digit of the multiplicand and a digit of the multiplier are accumulated separately to form two 'partial products', which are finally combined to form the product. For an m-digit multiplier the whole process takes $(m + 4)$ addition times instead of an average of $4\frac{1}{2}m$ addition times required for multiplication by continued addition. Not only is the saving of time important, but the fact that multiplication does take a definite time at all, and not a time depending on the particular digits of the multiplier, is important in the organisation of the computing process in any particular case.

The time taken for the multiplication of two 10-figure numbers is just under 3 millisec. Normally the multiplier is connected to give a 10-figure product without carry-over from the eleventh place; four accumulators are involved in such a multiplication, two for holding the factors to be multiplied, and two for accumulating the partial products. But it can be arranged to give the full 20-figure product; this involves the use of six accumulators. The circuits special to the multiplier take three whole panels (Fig. 1, f)

The multiplier has twenty-four program channels, with each of which is associated a group of switches on which are set the reception channels through which the numerical values of the factors to be multiplied are to be received, whether these are to be held or cleared after the multiplication is completed, the disposal of the product, the number of figures to be used in the multiplicand, and the number of figures to be retained in the product.

Divider and Square-rooter

There is also a unit for carrying out division and extraction of square roots. Division is carried out by a process of successive subtraction, the sign of the partial remainder being tested after each subtraction. The divider is first subtracted from the dividend until the sign of the remainder becomes negative; the remainder is then multiplied by 10 and the divisor added until the remainder becomes positive, and so on; count is kept, in an accumulator serving as quotient register, of the number of times the divisor is added and subtracted in the successive decimal places. This is a comparatively slow process; determination of an m-figure quotient takes on the average $13m$ addition times. But most computations can be so arranged that division is a comparatively rare operation, and it is not important to use a more rapid process for it.

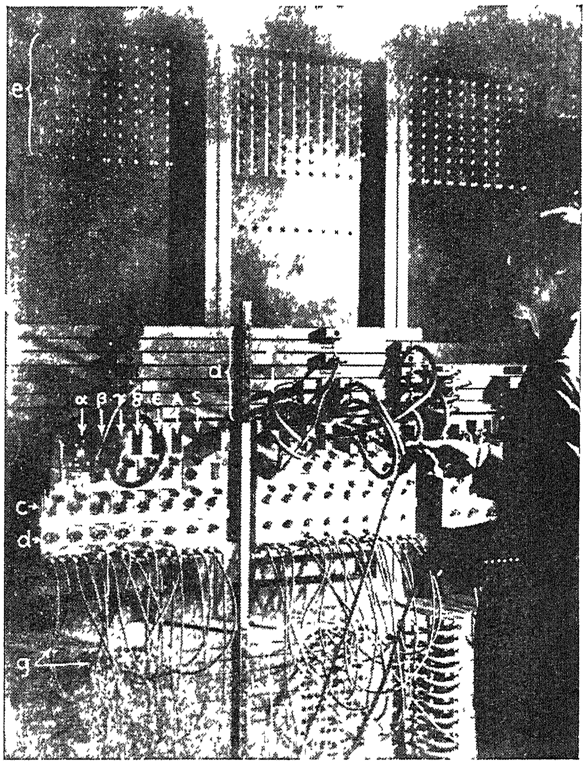

FIG. 3 FRONT VIEW OF ACCUMULATORS a, DIGIT TRAYS, b, PROGRAM TRAYS, c, OPERATION SWITCHES, d, REPEAT SWITCHES, e, INDICATOR LAMPS, f, CONNECTING CABLES BETWEEN DIGIT TRAYS AND ACCUMULATORS, g, CONNECTING CABLES BETWEEN PROGRAM TRAYS AND ACCUMULATORS α β, γ, δ, ε, TERMINALS OF ACCUMULATOR CHANNELS FOR RECEPTION OF NUMERICAL INFORMATION, A, S, TERMINALS OF ACCUMULATOR CHANNELS FOR TRANSMISSION OF NUMERICAL INFORMATION

Extraction of a square root is carried out by a similar process, which can be regarded as division by a variable divisor.

Since both these processes are slow, it is often advisable to carry out other steps of the computation in parallel with them if this can be done without conflict in the demands on the use of digit trays. Since the time occupied by a division cannot be determined in advance, it is necessary when this is done to have an interlock circuit so that a program pulse is not given out until both the division and the parallel program have been completed.

Function Tables, Input and Output Equipment

The ENIAC has three function tables (see Figs. 1, c and 2, h), each of which comprises an array of switches on which 6-figure values of two functions, with signs, or a 12-figure value of one function, can be set up for each of 104 values of an argument. These switches are connected up so that for any two-figure argument x from 00 to 99, input to the function table, the value of the function for that argument is output in the form of pulse groups on the appropriate digit lines. Also, if required, the values of the function for arguments $x \pm 1$ and also for $x \pm 2$ can be output for use in interpolation formulæ, the choice of which set of function values to take being determined by the setting of a switch, and the corresponding interpolation formula being set up by interconnexions of the multiplier, function table, and accumulators.

The ENIAC has also a 'constant transmitter' which has eight 10-figure relay registers to which numbers can be transferred from punched cards by means of a card reader (Fig. 1, *d*), and two 10-figure registers on which numbers can be set by hand switches; each of these ten registers can be used in two halves to give two 5-figure numbers if required. Each register has three program channels and on stimulation by a pulse on any of these, it transmits the number it holds to the common output channel of the constant transmitter, and thence to the digit tray to which this is connected. The accumulator to which this number is transferred has to be stimulated to receive on a channel connected to this digit tray.

The numbers held in the relay registers can be changed in the course of a computation by stimulating the reader to feed and read a new card; this is done by means of a program pulse to the reader itself. This is a comparatively slow process, and if any arithmetical operations are carried out in parallel, an interlock is necessary as on the divider.

Results are output in the form of punched cards, the card punch (Fig. 1, *e*) being stimulated by a program pulse at the proper stage in the sequence of operations. In addition, the machine can at any time be stopped, and the numbers held by the accumulators read by visual inspection of the indicating lamps associated with the counting decades. By the operation of a control switch, the machine can be set so that at each pressure of a push-button, the set of pulses emitted by the pulse generator in just one addition-time only is supplied to all units, so that the process of a computation addition-time by addition-time can be watched in detail by inspection of the numbers held by the accumulators after each time the push-button is pressed. This is most valuable in checking and in locating faults.

Master Programmer

The number of individual computing operations in any extended computation is much greater than the total number of program channels of all the units of the ENIAC, so that if each single operation had to be set up separately the capacity of the machine would be severely restricted. However, most extended computations involve the repetition of a basic sequence of computing operations, applied successively to different sets of numbers, though there may be breaks in the regular repetition of the sequence, either at predetermined points or at points depending on the results of the computation. For example, in the step-by-step numerical integration of a system of simultaneous ordinary differential equations, the basic sequence is the integration procedure for one interval of the integration, which is a sequence of operations starting from the initial values for that interval and giving final values which become the initial values for the next interval. In the course of such an integration, it may be required to break the exact repetition of the procedure by changing the interval-length, either at predetermined values of the independent variable, or at values to be determined by the behaviour of the solution. Evaluation of a formula for various values of the argument, and iterative calculations, are other examples of computations involving repetition of a basic computing sequence.

For purely repetitive calculations it is sufficient to set up the machine for the basic computing sequence, *and* for the step from the ending of one repeat of this sequence to the beginning of the next. For calculations which do, or may, involve departures from strict repetition of a basic computing sequence, means of carrying out these departures is required.

A most important unit of the ENIAC from the point of view of the organisation of a computation is that called the 'master programmer' (see Fig. 2, *e*), which handles automatically the repetition of a computing sequence and the change from one computing sequence to another, either at predetermined stages in the computation or at stages depending on some criterion (usually the sign of some number) applied in the course of the calculation.

The 'master programmer' operates by switching program pulses from one program line to another. It consists of ten six-position electronic switches called 'steppers', with each of which a counter can be associated. Each stepper has four input channels, and one output channel for each of its six switch positions. A pulse received on the 'normal input' channel gives rise to a pulse on the output channel corresponding to the switch position of the stepper, so that by connecting two or more of these output channels to different program lines, different computing sequences can be initiated by a program pulse on a single line, according to the switch position of the stepper. The counter, if used, normally counts pulses received on the normal input channel, but the number registered by it can also be advanced by pulses on a 'counter direct input' without giving any output pulses; the counter is reset to zero when the stepper moves from one switch position to another.

A stepper can be stepped from one switch position to the next in two ways: first, automatically when the number registered by the counter associated with it has reached a prescribed value previously set on a group of switches; secondly, by a pulse applied to the 'stepper direct input' channel. It can also be cleared back to its first position in two ways: first, by a pulse applied to the 'stepper clear' input channel; and secondly, an auxiliary switch can be set so that any chosen number q from 2 to 6 of the switch positions of the stepper are operative; the stepper is then cleared by a stepping pulse received when in its q-th position

To repeat a computing sequence, the normal input channel of a stepper is connected to the program line which receives a pulse from one of the units involved in the last step of a computing sequence, and one of the output channels of the stepper is connected to the program line on which a pulse stimulates the units involved in the first step of the sequence. Then so long as the stepper is in the switch position corresponding to this output channel, the computing sequence forms a ring of operations closed through the master programmer. A starting pulse supplied to the program line connected to the normal input of the stepper will then start the computing sequence, which will be repeated so long as the switch position of the stepper remains unaltered.

Use of the counter associated with a stepper enables the computing sequence to be changed after a predetermined number of repeats. Use of the stepper direct input enables it to be changed according to some criterion applied in the course of the calculation. This criterion is often the sign of a number occurring in the work, or of the difference between two numbers. Use of such a criterion involves taking pulses from a numerical transmission channel to a program line; this requires the use of a special adapter, but otherwise offers no difficulty.

The number of steppers available in the master programmer, and the possibility of interconnecting them with one another as well as with the part of the machine concerned with the arithmetical work, introduces a very considerable degree of flexibility into the ENIAC, and makes possible its automatic application to problems involving a considerable degree of discrimination and judgment. But it must be clearly understood that the situations requiring this judgment, and decision as to what action is to be taken in them, must be fully anticipated in the setting up of the machine. It can only do precisely what it is told to do; the decisions on what to tell it to do, and the thought which lies behind these decisions, have to be taken by those who are operating it. Use of the machine is no substitute for the thought of organising the computations, only for the labour of carrying them out.

Set-up and Use

In applying the ENIAC to any particular computation, it is necessary first to break down the work into a number of basic computing sequences, the ordering of which is controlled by the master programmer, and then to break down each sequence into the individual computing operations of which it is composed, which are carried out through the interconnexions of the arithmetical units of the machine.

In planning the organisation of calculations other than that of trajectories for which the machine was primarily designed, the main restriction found has been the small memory capacity into which numbers can be recorded, and from which they can be read automatically, in times of the order of a few addition times. This memory capacity consists of the twenty accumulators, but as four of these have assigned uses in any multiplication and another four in any division, not more than sixteen, and often fewer, can be regarded as available for storing intermediate results. This capacity is adequate for the original purpose of the machine, but for other and more extended computations it is often found that the method of calculation used is determined primarily by this question of memory capacity rather than by any other considerations.

The machine has an indefinitely large memory capacity in the form of punched cards, but both recording into and reading from this memory is comparatively slow—of the order of two or three thousand addition-times—and, further, its use for intermediate results which are required later in the calculation requires the attention of an operator to transfer cards from the punch to the reader. Thus although this use of punched-card memory greatly increases the power and range of the machine, it does so at the expense of the speed and fully automatic character of its operation.

However, powerful use can be made of the ENIAC in conjunction with punched-card equipment in other ways, particularly by means of the reproducing punch and the sorter. By means of these, results obtained as decks of punched cards in one set of calculations on the ENIAC can be rearranged on to other decks of cards in a convenient way to be used as input data to the card reader of the ENIAC in subsequent calculations. The scope and power of this use of the ENIAC and punched-card equipment in combination promises to be considerable.

Examples

The speed and power of the ENIAC can best be illustrated by examples. Its speed is so much greater than that of any other existing computing equipment that it is not easy to realize without some experience of the machine.

Multiplication is a so much slower process than addition, and division so comparatively rare, that the total time of a computation not involving large numbers of readings or punchings of cards can be estimated from the number of multiplications involved. A multiplication takes rather less than 3 millisec., so that a computation involving altogether ten million multiplications would take about 30,000 sec., or about $8\frac{1}{2}$ hours, and is therefore quite within the range of practical possibility, provided, of course, that this large number of multiplications arises from a large number of repetitions of a fairly short basic computing sequence and that the number of intermediate results to be remembered at any time is not beyond the capacity of the machine. Numbers of arithmetical operations of this order of magnitude are quite likely to be required now that equipment for handling numbers on this scale is available, though in several contexts, for example, evaluation of solutions of partial differential equations in three variables, or solution of large numbers of simultaneous algebraic equations, the memory capacity required is likely to be more than that available on the ENIAC without using cards.

An example of the speed and capability of the ENIAC is provided by a problem on which I used it while working at the Moore School. This was concerned with the solution of three simultaneous non-linear ordinary differential equations which arise in the theory of the laminar boundary layer in a compressible fluid. These equations are of the form $f' = h/[1 + \alpha r]^{1/9}$; $h'' = -fh'$; $\beta r'' + (h')^2 = -fr'$; ($\alpha$ and β being constants) with the two-point boundary conditions

$$f = h = r' = 0 \text{ at } x = 0$$
$$h = 2,\ r = 0 \text{ at } x = 5,$$

(the conditions $h = 2$, $r = 0$ are actually conditions at $x = \infty$, but it was known that to the 6-figure accuracy aimed at they could be replaced by conditions at $x = 5$). Solutions were required for each of a set of values of α. The awkward nature of the boundary conditions, rather than the form of the equations, is what makes the application of the machine so impressive.

The boundary conditions were satisfied by running trial solutions with different trial values of $h'(0)$ and $r(0)$ and adjusting these until the conditions at $x = 5$ were satisfied to 7-figure accuracy, no results being punched except initial and final values for each run. Approximate values for the variation of $h(5)$ and $r(5)$ with $h'(0)$ and $r(0)$ were available, and it was possible, by using the master programmer to switch from one computing sequence to another, to arrange that from any one set of values of $h'(0)$, $r(0)$, $h(5)$ and $r(5)$ the machine determined better values of $h'(0)$, $r(0)$, and continued this process of alternately evaluating a solution and determining better initial conditions from the results until a criterion was satisfied, after which a final solution was made, the values of f, h', h, r', r then being punched for every integration interval.

To avoid considerable demands on memory capacity, it was considered best to use a rather simple integration formula, and therefore small intervals of integration. Intervals $x = 0{\cdot}02$ were used, so that 250 intervals were required to cover the range $x = 0$ to 5. The integration was carried out at the rate of about eight intervals a *second*, a single trial solution taking about half a minute. The final run, punching a card for every interval of the integration, took about $2\frac{1}{2}$ minutes.

Thus once the ENIAC had been set up and provided with initial estimates of $h'(0)$ and $r(0)$, it carried out without further attention from an operator the determination to 7-figure accuracy of the values of these two quantities for which the solution satisfied the conditions at $x = 5$, and evaluated and punched 250 values of the final solution. The total time taken depended on the number of trial solutions required, but was about four minutes for each value of α.

A fuller account of this work is in course of preparation.

Acknowledgments

I wish to express my thanks to Colonel P. N. Gillon for making the arrangements which enabled me to obtain first-hand experience of the ENIAC and its use, to Dr. L. S. Dederick of the Ballistics Research Laboratory for agreeing to make the machine available for the work referred to in the section above, and to Dr. and Mrs. H. H. Goldstein and to members of the group operating the ENIAC, particularly Dr. D. H. Lehmer and Miss K. McNulty, for information, advice and help in setting up and operating the machine on this work.

[1] Bush, I V, *J Franklin Inst*, **212**, 447 (1931) See also Hartree, D R., *Math. Gaz.*, **22**, 342 (1938), *Proc Roy. Inst*, **31**, 151 (1940); and *Nature*, **146**, 319 (1940).

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JUBILEE OF THE MARINE BIOLOGICAL STATION, MILLPORT

By Prof. C. M. YONGE, F.R.S.

Chairman, Executive Committee, Scottish Marine Biological Association

ON October 17, 1896, the foundation stone was laid, by Dr. Thomas Reid, of the first building of the Marine Biological Station at Millport. The fiftieth anniversary of this important date in the history of marine biology in Scotland most happily coincides with the first joint meeting of the Challenger Society to be held at a marine station since the end of hostilities. Visitors to that meeting will see a laboratory greatly extended by buildings erected immediately before the outbreak of war and others acquired more recently. These make possible considerable increases to the staff and programme of the station.

The Millport laboratory has a dual origin. It came into being through the combined efforts of Dr. David Robertson, the "Naturalist of Cumbrae", whose life, under that title, was written by his friend, the Rev. T. R. R. Stebbing, and of Dr. (later Sir) John Murray. Thus, through Murray, the Station can trace its history back to the *Challenger* office and so to the expedition. In 1884, largely as a result of his efforts, a Scottish Marine Station was established in the Firth of Forth. In a submerged quarry at Granton was moored the *Ark*, an old lighter on which was built a wooden laboratory, while sea work was carried out from Murray's steam yacht, the *Medusa*. In the summer of the following year both vessels were taken through the Forth and Clyde Canal to Millport. Murray's intention had been to move about the west coast of Scotland; but the presence of Robertson at Millport and its excellent position as a centre for work in the Clyde sea area induced him to establish the laboratory permanently on the Island of Cumbrae. Eventually the *Ark* was drawn up on the shore near Farland Point on the east side of Kames Bay, where she remained in continuous use until destroyed in a great storm on December 20, 1900.

This early period of marine work at Millport saw the production by Murray and H. R. Mill of a notable series of papers on the configuration and physical conditions with special reference to marine life in the Clyde sea area. When this work was finished, the *Medusa* returned to the east coast, but the *Ark* remained at Millport and became to a large extent the personal laboratory of Dr. Robertson until, in 1894, it was lent to a committee formed for the purpose of establishing a marine biological station at Millport. During the following three years no less than thirty-one persons, among them E. W. MacBride, Robert Broom and J. F. Gemmill, the last to be intimately associated with the station for many years, worked in this simple but effective laboratory.

The foundation of a permanent station followed quickly. Dr. Robertson cut the first sod on August 7, 1896, but was too ill to attend the laying of the foundation stone in October and died on November 20. The buildings were opened, appropriately by Murray, on May 17, 1897. In 1901 the title of the controlling body was changed to the Marine Biological Association of the West of Scotland and so remained until 1914, when it assumed its present title of the Scottish Marine Biological Association.

The original building contained living accommodation for the curator (this now forms the office and two small research rooms) and a laboratory divided into cubicles, with a tank room and an engine room behind. Above were housed the Robertson Museum, presented by Mrs Robertson, and behind it the library. The *Ark* continued in use until its destruction. Work at sea was carried out from the *Mermaid*, a wooden steam yacht 65 ft. long. In 1904 the present director's house was built and the laboratory extended by the erection of a wing, at right angles to the original block, which houses the aquarium below and a class-room above. The buildings remained in essentially this condition until 1939.

The period 1905–14 was one of considerable difficulty, and for a while the fate of the Station hung in the balance. The first scientific director, S. Pace, left in 1907 and was succeeded as superintendent by the present director, Mr. R. Elmhirst, who had been appointed naturalist the previous year and who thus now completes forty years of service. Generations of students, among whom the writer is glad to include himself, have had their first instruction in marine biology from him, and there is little doubt that without his cheerful optimism and persistence in difficult days the Millport Marine Station would not exist to-day. Reference must also be made to the services of Mr. John Peden, appointed laboratory assistant in 1906 and still happily in the employment of the Laboratory, who maintained it during the period of

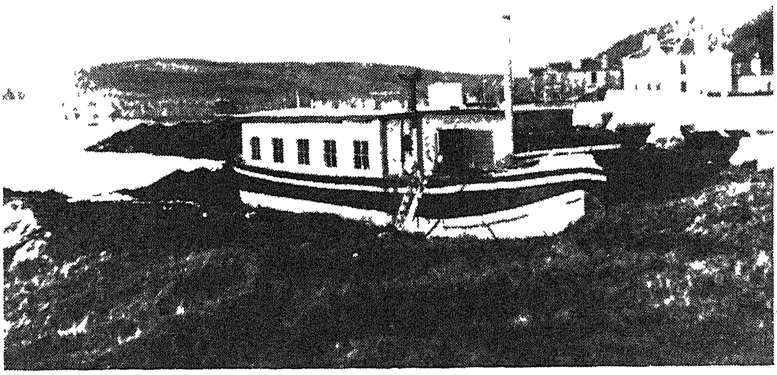


Fig 1 THE *Ark* DRAWN UP AT FARLAND POINT, MILLPORT

the First World War when Mr. Elmhirst was on war service.

The modern period of expansion may be said to date from 1921 when the Association first received financial help from the Development Commission. The staff was enlarged by the appointment of Dr. Sheina M. Marshall and Dr. A. P. Orr, whose joint work on plankton and the physico-chemical conditions in the sea have become part of the fundamental literature of marine biology and gained the Millport Laboratory international recognition as a centre of fundamental research. They were joined later by Dr. A. G. Nicholls, now in Western Australia, and work was extended to the biology of young herring. Meanwhile important faunistic and ecological work was carried out on the inter-tidal fauna by the director and many visiting workers, among whom may be mentioned Dr. A. C. Stephen and Dr. E. E. Watkin. Dr. Nicholls explored the newly discovered fauna of sand-living copepods. The rich and easily available supply of echinoderms and the purity of the surrounding sea water were utilized especially by Prof. J. Gray, Dr. G. S. Carter and Lord Rothschild in studies on the physiology of fertilization. A general account of the activities of these years has been given by the director in a short account of "Marine Biology in the Firth of Clyde" (*Scottish Naturalist*, July–August 1939), while in the annual report of the Association for 1938–39 he gave a bibliography of publications dealing with work carried out at the Station from April 1897 to March 1939, which comprises 292 titles.

This period of expansion owes much to the activities of Prof. L. A. L. King, Prof. F. O. Bower and especially Prof. (now Sir John) Graham Kerr, who was chairman of the Executive Committee until his resignation from the regius chair of zoology in the University of Glasgow in 1935. His successor, Prof. E. Hindle, will similarly be remembered with gratitude for the energy and success with which he pressed forward the schemes for expansion which culminated in the erection, parallel to the original block, of a fine modern wing which was opened in June 1939. This contains on the ground floor a tank room, a receiving room and six work rooms; on the floor above a class-room for advanced students, a specimen store, a dark room, a chemical laboratory, and a balance room, and four work rooms. By converting the cubicles in the old building into a museum, the original museum has been cleared and is now a spacious and well-fitted library, the contents of which are being rapidly increased.

During the Second World War the Station suffered a great loss in the death in action of Mr. W. N. Paton, who had succeeded Dr. Nicholls and was a marine biologist of the highest promise. His place has recently been filled by the appointment of Dr. R. B. Pike. Dr. Marshall and Dr. Orr did important national service by working out methods of extraction and preparation of agar from the British red sea weeds, *Gigartina* and *Chondrus*, and by surveying large areas of the Scottish coasts for supplies of these algæ. Their methods have now been developed industrially and represent an important contribution from marine biology to British commercial enterprise. In addition, these members of staff collaborated in experiments initiated from the University of Edinburgh on the effects of artificial enrichment by nutrient salts in sea lochs on the Argyll coast.

The enlarged premises of the Station have been fully utilized by the presence since 1941 of a team of workers engaged on research into anti-fouling

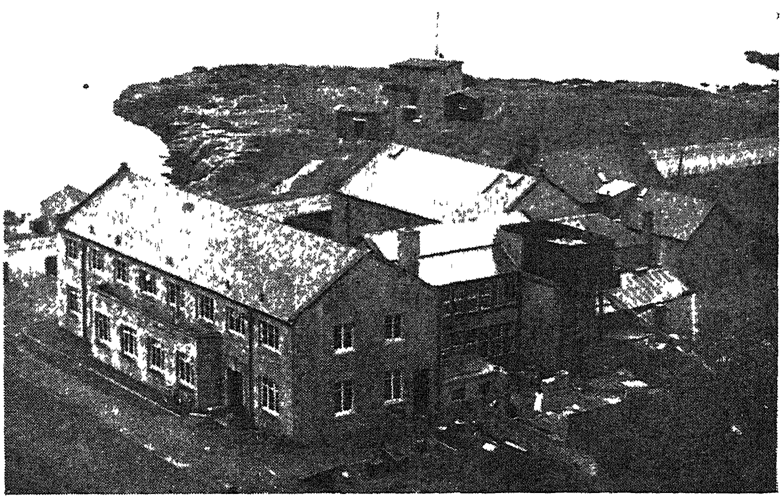


Fig 2. THE MARINE BIOLOGICAL STATION, MILLPORT, IN 1946. THE NEW WING, COMPLETED IN 1939, IS SHOWN ON THE LEFT; THE EX-ADMIRALTY BUILDINGS LIE ACROSS THE ROAD IN FRONT OF THE STATION

measures for the Marine Corrosion Sub-Committee of the Iron and Steel Institute, initially under the direction of Dr. J. E. Harris and, since his appointment to the chair of zoology in the University of Bristol, by Mr. K. A. Pyefinch. The presence of this active team has been greatly appreciated, and it is hoped that this work will be continued at Millport for many years. Difficulties of space will arise owing to forthcoming increases in the staff of the Station, but fortunately a series of buildings erected by the Admiralty across the road in front of the Station have been acquired (the cost being kindly defrayed by an anonymous donor) and, after appropriate alterations have been made, it is intended to transfer the anti-fouling team to the largest of these premises until separate buildings for their use can be put up.

The Millport Laboratory is thus in fortunate possession of adequate modern buildings and of a small but highly efficient scientific staff. A comprehensive programme of research involving a considerable increase in staff and the acquisition of a larger boat in place of the *Nautilus*, the 39-ft. motor vessel which has been in use since 1922, has been presented to the Development Commission. Two new members of staff, a zoologist and a chemist, are being appointed immediately, and it is hoped to raise the staff to a total of ten within the next few years. Hitherto confined to the Clyde sea area, the activities of the station are now to be extended along the west coast of Scotland, and this summer two parties of workers have been engaged along the coast of Argyll, one in Loch Sween, where a mobile laboratory is in use, and the other at Easdale. Both have been concerned with the possibilities of breeding and farming oysters. For the first time this summer the *Nautilus* passed through the Crinan Canal and carried out dredging operations in Loch Sween and West Loch Tarbert— a notable event in the history of the Station. But the larger boat will be necessary to take full advantage of the rich possibilities for marine research in these waters, the fauna of which may, in the deeper areas, some of which are exposed to the scouring action of powerful tidal currents, prove to be as rich as that of the Norwegian fjords.

A far-reaching programme of research on the plankton community will, with the advent of new members of staff, be initiated next year, and the fundamental research on which the reputation of the Station has been established will thus be extended. Increasing attention is being paid to the adaptations and ecology of bottom-living and shore animals, especially the former, which provide the link between the plankton and demersal fish. Other projects include further work on herring, investigation into the life-history and migrations of the scallop (*Pecten maximus*) and the running of an experimental lobster hatchery on the American pattern to determine whether the larvæ of the European species can be as successfully reared to the bottom-living, lobsterling stage as can those of *Homarus americanus*.

The Scottish Marine Biological Association looks forward to a future of ever-increasing activity over a wide area of the most diversely varied coast around the British Isles. It aims at providing the essential background of pure research to the manifold activities of the Scottish marine industries in particular and to those of Great Britain and Western Europe in general. At the same time it offers greatly enhanced facilities for teaching and especially for the carrying out of original research in all branches of marine biology, including physiology and algology.

OBITUARIES

Mr. Harold J. E. Peake

HAROLD PEAKE, son of the Rev. John Peake, vicar of Ellesmere, was born on September 29, 1867, and died on September 22, 1946, at his home at Boxford, near Newbury. He belonged to the characteristically British tradition of the man of leisure who, without professional commitments, devotes himself to intellectual and public work. One thinks of Charles Darwin and Francis Galton, among others, in this connexion. An early training at Leicester for estate management gave Peake insight into problems of land tenure and land use on a historical basis, and resulted later on in a valuable study of old roads (published in "Memorials of Old Leicestershire"). In 1897 he married Miss Charlotte Bayliff and they went round the world, staying some time on a ranch in British Columbia, from the life of which Peake gained clues to his later interpretations of pastoralism in prehistoric times.

Settling in 1899 at Boxford, Peake's house gradually became a centre of light and leading not only for the Newbury district but also for many students of humanity, including younger men whom he helped with his fund of knowledge and his quick flow of ideas mingled with a happy though penetrating wit. One recalls his answer to a foreign visitor's query about the grandstand at Newbury Racecourse; it was, said Peake, a temple of our national religion! He studied man, ancient and modern, with a keen perception of the problems that communities have had to face, and he formed a Citizens' Association at Newbury, and then became honorary curator of Newbury Museum, chairman of the governors of Newbury Grammar School, chairman, and later president, of Newbury General Hospital. At the same time he played his very active part at the Royal Anthropological Institute, of which he became president (1926–28), and at the Society of Antiquaries, serving on its Council during 1928–30. He was a regular attendant at meetings of the British Association for the Advancement of Science and was president of its Anthropological Section in 1922. The Royal Anthropological Institute gave him its Huxley Medal in 1940.

Peake was deeply convinced of the evolutionary interpretation of the story of mankind, and he sought to illuminate many dim corners, particularly the origins of cultivation, of cultivated grain, of ploughing, of metallurgy, of social hierarchies, and of mythologies that succeed one another in the general history of religion. "Ritual continues, its explanations wax and wane." It was a delight to hear his endless suggestions about ancient herdsmen and their seasonal ceremonies for the sorting out of the animals, and their butchering hoists giving the idea of pillars and lintels around a corral and leading on from wood to stone at Stonehenge with a number of new meanings and associations; or, it might be, his view, not always accepted, that prehistoric Beaker pottery was largely a copy of certain kinds of painted pottery by people who were not skilled in painting and who incised the surface for ornament, no doubt recalling at the same time a grass bag technique. His friends celebrated his studies of early wheat (Emmer) by a Christmas card showing Harold chasing 'Wild Emmer' over the hills around the Fertile Crescent.

Peake's Museum at Newbury was unique in its arrangement. The evolution of forms of life was traced up to man, he being represented by a mirror with *Homo sapiens* written over the top, so that the visitor might realize himself as the product of evolution. Then followed a few carefully selected exhibits of early times beyond accurate dating. The later period, from 3000 B.C. to 2000 A.D., was illustrated by a long wall-space divided equally for the fifty centuries and showing specimens (especially pottery), maps and labels to illustrate the life of the Old World at each stage. A Newbury school-boy, who had used the Museum to some purpose, was being told by an inspector of things that happened "very long ago". The inspector was pleasantly startled to be told, "Oh, but that was in the La Tène period, quite recent in fact".

The "Corridors of Time" (with H. J. Fleure), "The English Village" (1922), "The Bronze Age and the Celtic World" (1922), "The Beginnings of Civilization" (*J. Roy. Anthrop. Inst.*, 1927), "The Introduction of Civilization into Britain" (*ibid.*, 1928), "The Study of Prehistoric Times" (*ibid.*, 1940), and many other contributions to the *Journal of the Royal Anthropological Institute* and to *Man*, as well as to the *Transactions of the Newbury Field Club*, to the "Victoria County History of Berkshire", the books of general exposition "Origins of Agriculture" (1926), "The Flood" (1930) and "Early Steps in Human Progress" (1933) all gave his ever-developing views of the story of humanity.

No account could be satisfactory without mentioning Westbrook House at Boxford, presided over until her death by Mrs. Peake, always brimming with keen intellectual and artistic interests, especially in amateur drama and singing among village folk. For more than forty-five years, Miss Mary Wilson, aided by her colleague Miss Annie Plumb, were the domestic staff and friends of Mr. and Mrs Peake and of all who gathered around them. Miss Wilson's help in both dramatic efforts and prehistoric studies were gratefully acknowledged. H. J. FLEURE

WE regret to announce the following deaths:

Sir Frank Heath, G.B.E., K.C.B., the first secretary to the Department of Scientific and Industrial Research, on October 5, aged eighty-two.

Sir Walter Langdon-Brown, emeritus professor of physic in the University of Cambridge, on October 3, aged seventy-six.

Prof. H. C. Plummer, F.R.S., formerly professor of mathematics at the Military College of Science, Woolwich, on September 30, aged seventy.

NEWS and VIEWS

Committee on Defence Research Policy

A WHITE PAPER has been issued announcing the creation of the office of Minister of Defence, who is to be responsible to Parliament for certain subjects affecting the three Fighting Services and their supply. Mr. A. V. Alexander, formerly First Lord of the Admiralty, has been appointed to the new office. Defence as a whole will be in the hands of a Defence Committee under the chairmanship of the Prime Minister and including as regular members the Defence Minister, the Lord President of the Council, the Foreign Secretary, the Chancellor of the Exchequer, the Service Ministers, the Minister of Labour and the Minister of Supply. Referring to research, the White Paper states that the chief problem is to ensure the continued and complete integration of military and scientific thought at all levels. Full account must be taken of scientific effort in all fields, so that the resources of the country may be used efficiently. To this end a Committee on Defence Research Policy is to be formed, with a permanent chairman who will be a man of science of high standing. This Committee will consist of those responsible, from the operational and scientific points of view, for research and development in the Service Departments and the Ministry of Supply; it will advise the Chiefs of Staff on operational questions, and the Defence Committee itself on wider aspects of the problems involved. Much will, of course, depend on the composition of this Committee on Defence Research Policy; but by this arrangement the machinery is available to ensure that full weight will be given to scientific developments in all matters that are likely to concern the defence of the country.

Consulting Work and Educational Institutions

A STATEMENT issued some time ago by the Joint Council of Professional Scientists dealt with the principles which should govern the acceptance of consulting work by academic men of science (see *Nature*, 157, 86; 1946). A somewhat similar code is incorporated in "A Statement of Research Policy suggested for Inclusion in Research Policies of Educational Institutions", which has been prepared by the Association of Consulting Chemists and Chemical Engineers in the United States and published in *Chemical and Engineering News* of June 10. The statement suggests that it should be the policy of educational institutions to undertake as a rule only such research projects sponsored under contract with industry, government agencies, philanthropic or scientific organisations as seem likely to add to the knowledge of fundamental research, are financed on a basis which contributes to the institution's own research fund, and have as objective the training of research workers. Further, they should extend over a period of a year or more, they should not restrict the institution from undertaking other projects or research, and they should be such as cannot advantageously be undertaken by independent research or development laboratories. Besides this suggested policy, which would seem to be open to evasion or abuse, there are in the statement regulations proposed for private consulting service and for co-operative research, the latter specifying the information to be supplied to the institution before work is begun. As regards commercial testing, it is suggested that no routine commercial testing or analysis of materials, substances or products which might be carried out by an independent industrial or commercial laboratory should be permitted, although tests or analyses intended chiefly to develop new scientific facts should be allowed when they are part of a research programme or necessitate apparatus or equipment not available in private laboratories.

Child Health in Great Britain

A BROADSHEET (No. 248, Child Health and Nutrition) issued by Political and Economic Planning as a study of the services dealing with the nutrition and health of children, complementary to the study of the maternity services published early in the year, is of renewed interest in view of the food situation and the National Health Service Bill. Pointing out that the primary responsibility for bringing up healthy children must rest on the care and wisdom of their parents, the broadsheet emphasizes that if the retreat from parenthood is to be arrested, the skilled services and economic aid required to restore Britain's greatest and most neglected productive activity—parenthood—must be provided readily and without stint. Present divisions of the welfare and school medical services militate against continuity of medical care for the individual child, and its critical analysis of the present and future services leads P E.P. to stress that in the nutritional field the greatest need is to implement fully the powers and duties that already exist, while the first need for the child health services is for co-ordination. Co-operation between health visitor and general practitioner, medical officer and children's physician is made difficult by the present administrative arrangements. Secondly, a medical service for children should be fundamentally a health service rather than a sickness service. The health services should study normal growth and development, about which too little is known, and the broadsheet strongly emphasizes the importance of research. Without a high standard of medical teaching and much extended research on such problems as breast-feeding, nutrition, physical education, the influence of social factors on child health, and on all the aspects of normal growth, the best organised medical service can do little. With the proposed organisation of the hospital services in university regions, the future institutes of child health should be able to extend their influence beyond the immediate confines of the teaching centre and raise the standard of all child health services in the region.

The National Grid of the Ordnance Survey

THE Departmental Committee appointed in 1935 by the Minister of Agriculture and Fisheries to consider Ordnance Survey plans and maps recommended that the large-scale plans of Great Britain should be re-cast on national sheet lines and that a national grid, with the metre as unit, should be superimposed on all large-scale plans and most of the small-scale maps The recommendation compels the use of a projection that will not introduce unacceptable distortions, on any of the scales, when it is extended over an area the size of Great Britain. Accordingly an orthomorphic projection, known as the Transverse Mercator, with its origin at lat. 49° N., long. 2° W., has now been adopted as the national projection for general use over Great Britain. When rectangular co-ordinates are referred to this origin, the easting co-ordinates of points to the west of the central meridian are negative, and the northing co-ordinates, though all positive, become inconveniently large for points in northern Scotland. To avoid these difficulties, 400 km. have been added to all easting co-ordinates and 100 km. subtracted from all northing co-ordinates. This places the working position of the origin a little to the south-west of Lands End and ensures that the co-ordinates of all points on the mainland of Great Britain are positive and less than 1,000 km.

The Ordnance Survey has now issued a pamphlet (Booklet No. 1/45, "A Brief Description of the National Grid and Reference System", H.M. Stationery Office, 1946. 4*d*. net) which briefly describes the geodetic and mapping situation in Great Britain at the time the Committee was appointed, and the steps taken to implement its recommendations. It then details a method of giving the grid reference of any point on maps and plans of all scales This pamphlet will be of the greatest value to all map users, and to students of geography in particular, for whom the national grid will provide a most convenient aid for the recording of positions and statistical information.

Work of Cultural Missions

WHETHER as regards its origin, its immediate significance, or its promise for the future, Bulletin 1945, No. 11, of the Federal Security Agency (U.S. Office of Education) entitled "Report on the Cultural Missions of Mexico" is a noteworthy report. Its subject is the mission work done by a band of enthusiastic and patient Mexicans among the Indians in their remote villages. A preface written by Mr. J. W. Studebaker, U.S. Commissioner of Education, reveals that in September 1943 he had the opportunity of meeting the writer of the report and of visiting with him a group of Indian villages in which one of the missions was functioning. The report was thereupon written by the chief of the missions department, and here is the English translation. The work being done, says Mr. Studebaker, was an inspiration to him as an educator and as a citizen of a neighbouring country. The broad educational objectives, he proceeds, and the methods employed in this project for teaching Indian people a better way of life give confidence and inspire one with the belief that an isolated and somewhat estranged people of a great land will, through these means, be prepared for modern life and brought into the fold of genuine citizenship. Mr. Studebaker's closing words strike one as most remarkable. It is hoped, he says, that this report will contribute to a greater understanding of the important educational accomplishments "of our nearest southern neighbour, and that it will constitute an inspiration and a challenge to the educators of the United States". Following the report itself, a number of interesting and informative photographs, supplied by the author of the report, are added. Further, in order that the reader may secure more information concerning cultural missions in Mexico, either from English or from Spanish sources, a list of related readings, prepared in the Division of International Educational Relations, is included.

Fuel Economy in the United States since 1939

THE United States National Committee of the World Power Conference (Central Office, 36 Kingsway, London, W.C.2) has issued a report on that country's reactions to war conditions. Economy of fuel was necessary, but in ways which differ from those experienced in Britain. Since hostilities ceased, except for temporary effects, such as labour troubles, difficulties have disappeared and efforts to save fuel are based on economics rather than availability of supplies. During the War, production suffered from labour troubles and especially transportation problems. This led to an increase in the use of hydro-generated electricity from 44 to 80 billion kWh. Attempts were made to increase production—by technical devices in the case of liquid and gaseous fuels. In coal production, major developments were "salvaging coal formerly rejected", which recalls British use of 'outcrop coal' and 'washery slurries'.

Alternative fuels such as 'coal oil' mixtures were tried but not used extensively. Contrary to present British practice, the principal change was from oil-firing to coal-fired equipment, and in household use from oil to gas. There were control organisations—a petroleum administrator and a 'solid fuel administrator', and as civilian fuel became short, rationing was developed. Judged by British standards, the measures adopted do not sound onerous. For example, the general consumer would experience a restriction of solid fuels to seven-eighths of normal use. Various steps to conserve fuel were enforced, such as the adoption of 'brownout' and 'dimout' rules, reduction of space heating and organisation of a fuel economy campaign.

Post-war conditions are expected to bring more efficient equipment in domestic practice Where hydro-electric power is available, and off-peak current can be used to store heat, there will be more space-heating by electricity. No great reduction of fuel consumption is anticipated, however, in view of the increased demand for improved amenities. No radical improvements in conventional equipment are expected. New designs include the gas turbine, hot-air turbine and the heat pump for cooling and heating. The War has compelled increased interest in fuel education—enforced by the "advent of shortages and increases in the relative costs of fuel". In this respect conditions resemble those in Britain.

Abnormal Solar Radiation on 75 Megacycles

Messrs. S. E. Williams and P. Hands, of the Department of Physics, University of Western Australia, have sent a long communication referring to observations made there of solar radio-frequency radiation on a wave-length of 4 metres, using a Yagi aerial of moderate directivity, mounted on a polar axis. Measurements of the ratio of currents due to solar-plus-receiver noise and receiver noise only, recorded with the dipole short-circuited, were made with a milliammeter in the anode circuit of the (linear) second detector. Later an oscillograph was used to secure a continuous record. Continuous observations were maintained for from three to five hours each day, during the passage of the large sunspot group having mean meridian passage on July 26 7 (G.M.T.) and the two following groups with mean meridian passage on August 2 4. On the basis of these observations they divide solar radio-frequency noise roughly into two components, one 'steady' or relatively slowly variable (Component I), the other abruptly variable (Component II) A striking example of the variation of the so-called Component II was observed on August 2, when it was estimated that this 'storm' involved changes in noise emission by 50–100 *times* in a few seconds.

These short-period variations during 03h. 14m. 10s.–03h. 29m. 10s. (approx. G.M T.) corresponded with visual changes on the sun's disk as recorded on spectrohelioscope observations made by Watheroo Magnetic Observatory. A similar but less intense disturbance, during which the milliammeter showed increases in solar/receiver noise from 10 per cent to more than 150 per cent, was recorded on the same day between 04h. 51m. and 04h. 57m. 30s. (G.M.T.), when ionospheric equipment at Watheroo recorded a fade-out of intensity 4 (scale 1–9) during 04h. 45m.–05h. 00m., followed by a spectrohelioscope report of a faint prominence at 05h., indicating a flare at about 04h. 50m.

Messrs. Williams and Hands point out that since 75 mc./s. radiation cannot penetrate regions where the electron density is greater than 10^8/c c., which would be exceeded in the lower chromosphere, the correlation of solar noise generation with prominence activity seems probable. Further, as disturbances involving the emission of Component II are not necessarily accompanied by fade-outs, whereas chromospheric flares occurring within an hour or so of local apparent noon almost always produce fade-out effects, they suggest that correlation of Component II with flares would not be generally observed, but that coincidences between these phenomena would depend on the level at which increased excitation of the $H\alpha$ line occurs. This note of work at the University of Western Australia should be read in conjunction with the communication by Dr. A. C. B. Lovell and C. J. Banwell on p. 517 of this issue of *Nature*.

Survey of British Somaliland

SUGGESTIONS for a general survey of British Somaliland were made before the War in connexion with water supplies, soil erosion and other problems affecting the general development of the country, but were not put into execution at the time. The Military Government of the Protectorate has now issued a report outlining surveys made and data collected from 1942 onwards, and recording the work of a special department under Major J. A. Hunt from its inception in August 1943 until December 1944 (Report on General Survey of British Somaliland, 1944. Pp. 12 + 17 charts. (Burao: Gov. Press, 1946.) 3*s*. 6*d*.). The programme of work of the department conforms roughly to that advocated by Dr. E. B. Worthington in "Science in Africa", and starts with the accurate collection of meteorological and geological data, followed by a soil survey, plant and then animal ecology. The preliminary results are illustrated in a series of maps and diagrams published with the report, covering rainfall, plant ecology and tribal migrations and potential developments in minerals, water, agriculture and roads. The General Survey has now been recognized in principle by the Colonial Office, and funds have been provided under the Colonial Development and Welfare Act to finance an "economic survey and reconnaissance" with a programme extending until 1950. The water and mineral surveys will be made by two specialist geologists on arrival and may take up to two years. Altitude, rainfall and plant ecology are closely inter-related, and rain crop cultivation can only be considered and tested in a limited area above 4,000 ft. Sites are recommended for irrigation gardens and date plantations, and a new road from Berbera to El Afwein and Hudun is recommended as being situated on the most direct route to the eastern part of the Protectorate with no difficult escarpments to surmount. The Military Governor points out in his introduction to the report that the political and economic life of the Protectorate and neighbouring countries is threatened by increasing migrations of Somali tribes, who will be unable to find subsistence in their own country if conditions continue to deteriorate. The report strongly recommends publication of reports and specialist papers to stimulate interest in research, and also that when the two years survey of water and minerals has been carried out, the Survey should organise a technical library and laboratory in Burao, which is the natural centre for any scientific work in the Protectorate.

International Students' Federation

THE account given in the first issue of the *British Medical Students' Journal* of events which led to the formation of the new International Students' Federation and of the rebirth of the Czech universities is grim but inspiring reading. On November 17, 1939, the Germans closed the Charles University at Prague, shot nine heads of the student organisations and sent many male students either to concentration camps or to enforced labour in Germany. In memory of these and other early sacrifices, this day was celebrated in Britain and elsewhere as International Students' Day, and by the end of the War it was being celebrated all over the world as a day of remembrance and renewed resolve. The Czech students in exile in Britain wished that the first peace-time celebration of this day should be held in Prague, and, in November 1945, they invited students from fifty-one countries to be their guests. Some four hundred students accepted this invitation, and the article pays a tribute to the Czech students—and, indeed, to the whole population—for their reception of so many visitors only six months after the liberation of the country. Working in co-operation with the National Union of Students, a preparatory committee had already drafted the constitution of the new International Students' Federation. Co-operation with the World Federation of Democratic Youth and with the World Youth Conference held in London in November 1945 ensured further progress. The Prague Congress in 1945, an account of which is given, expressed the hope that the new International Students' Federation would be finally constituted during the summer of this year.

Working in Wood

UNDER the auspices of the Department of Scientific and Industrial Research the Forest Products Research Laboratory has issued a "Handbook of Woodcutting" (H.M. Stationery Office, 1946. Pp. 44. 9*d*. net) by P. Harris. Owing to the numerous requests received at the Laboratory for help in sawmilling and wood-working problems, it became obvious that a handbook on correct technique was required. The present publication is designed as a handy reference book, with a scientific background, from which the mathematical aspects of the subject have been omitted, with the exception of certain simple formulæ. The handbook contains detailed information and recommendations relating to the various forms of sawing and to planing, moulding, tenoning, mortizing, boring and turning operations. Diagrams and tables are added where necessary. Now that the area of forests is growing so convincingly in Great Britain, it is to be hoped that the time-honoured forms of handling wood by hand turnery, bending, shaving, toy carving and so forth, for all of which certain types of tools are required and must be kept in perfect condition, will be kept alive or brought back—especially hand carving by the new forest populations, as so commonly to be found in parts of Europe.

The European Chafer in America

THE Cornell University Agricultural Experiment Station has issued Memoir 266 on the "External Morphology of *Amphimallon Majalis*, the European Cockchafer", by F. H. Butt (University Ithaca, New York, December 1944). The European chafer, it is of considerable interest to hear, is a very modern introduced species, first reported in Wayne County, New York, in 1942, as being very destructive to lawns and to pasture lands in this region, the greatest destruction being done during its larval stages. The insect was closely studied in its three larval stages, and a life-history was published in 1943. The paper describes the external morphology of these various stages of the insect, with thirteen excellent plates. The generic name *Amphimallon* is attributed to Latreille. Most entomologists and foresters of the older generations will be better acquainted with the insect under its old-time name of *Melolontha vulgaris*, a well-known pest in European continental hardwood forests, especially oak, as is the case in Great Britain.

X-Ray Analysis in the Steel Industry

THE X-ray Analysis Group of the Institute of Physics has arranged a meeting to take place in the conference hall of the Royal Victoria Hotel, Sheffield, on November 8 and 9. On November 8, Dr. A. J. Bradley will speak on "The Intensity Relations of Debye–Scherrer Powder Diffraction Lines", and Dr. W. A. Wood on "The Application of X-rays to the Study of Stresses in Metals". The morning session on November 9 will include three papers, one by Prof. G. I. Finch on "The Surface Structure of Metals", one by Mr. H. J. Goldschmidt on "An X-ray Investigation of Electro-Deposited Chromium", and one by Dr. A. H. Jay on "Some Successes and Failures in the Application of X-rays to Industrial Problems" The meeting is open to all without charge; those who wish to take part in the discussions following these papers should notify Mr. F. A. Bannister (Hon. Sec.), Department of Mineralogy, British Museum (Natural History), London, S.W.7.

Racemic Acid

IN an interesting paper recently available in Britain, Prof. Delépine (*Bull. Soc. Chim.*, 8, 463; 1941) gives some historical facts relating to the discovery of racemic acid, which supplement the note by Prof. A. Findlay (*Nature*, 140, 22; 1937). The acid was obtained accidentally in the crystallization of tartaric acid in a factory in Thann, Alsace, belonging to Kestner, which seems to have ceased operations about 1822, and is first mentioned by John in his "Handworterbuch der allgemeinen Chemie" in 1819. The name 'racemic acid' was first used by Gay-Lussac in his lectures, notes of which were published in 1828, and he showed that it had the same composition as tartaric acid. Berzelius, in 1830, in discussing this fact, first used the word 'isomer'. The further history of the acid, in particular in the work of Pasteur (who was the first to use the name 'racemic' in general), is given in the article.

Journal of the British Grassland Society

THE first number of the *Journal of the British Grassland Society* has now been issued. The price of Volume 1 (Nos. 1 and 2), 1946, is 10*s*., and application for purchase should be made to the Secretary, British Grassland Society, Agricultural Research Building, Penglais, Aberystwyth. The volume opens with a foreword by Sir George Stapledon and also includes his presidential address, with ley farming as its principal theme, given at the inaugural meeting on June 20, 1945. Other contributors deal with various questions of interest in grassland management. In tests to compare different techniques for measuring grass production, a close correlation is shown between output in terms of grass clippings by the movable cage method with that from live weight increase in grazing cattle. Other grazing experiments on reclaimed upland areas in Montgomeryshire are described, in which re-seeding appears to have considerably improved the carrying capacity of the land. Practical advice on silage-making and its place in good grassland management is the subject of a further article, silage both being a valuable food and a useful means of controlling the sward and, moreover, not entailing heavy capital outlay or expensive equipment. From a detailed account of severe leather-jacket attack on re-seeded grassland in Yorkshire, there seems at present no really efficient means for controlling this pest on a farm scale, though attention to drainage, close grazing during the late summer when egg-laying takes place, and the maintenance of fertility are evidently factors which may lessen the degree of attack. A feature of this first number are the good photographs which illustrate each of the articles.

Japanese Men of Science in Malaya during the War

DR. H. E. DESCH writes to state that he wishes to make it clear that he does not endorse the conclusions and inferences to be drawn from Mr. E. J. H. Corner's letter on this subject which appeared in *Nature* of July 13. He is not prepared to enter into a lengthy correspondence, but directs attention to one point of fact. The format of Symington's "Foresters' Manual of Dipterocarps" was in no way determined or influenced by the Japanese; it was already in page proof before the Malayan campaign, and half the page formes survived the effects of blast from demolitions adjacent to the Caxton Press works. Because of this fact, Mr. Lebroy of the Caxton Press reset the remainder of the work and printed the whole for a figure that the Japanese ultimately accepted. Re-setting was done from a galley proof handed to Dr. Desch by Mr. Symington's Malay assistant.

Mathematics at University College, Southampton: Prof. E. T. Davies

DR. E. T. DAVIES, who has just been appointed to the chair of mathematics at University College, Southampton, is one of the outstanding leaders of research in modern differential geometry. He graduated at the University College of Wales, Aberystwyth, in 1925, and was awarded a research studentship which took him to Rome to study under Levi-Civita The next two years he spent working under Cartan at the Sorbonne. His researches in Rome and Paris under two great geometers had a decisive influence on his future work. Since 1930 he has been lecturing at King's College, London, and has been developing a fertile and original field of research which may be generally described as resulting from the action and reaction of differential geometry and the calculus of variations. He has studied problems of deformation of sub-spaces, of 'imbedding', of automorphism, and of the variation of multiple integrals. His later papers give a unified treatment of all geometries having a vector density as element of support, and thus generalize the work of Carton and Finsler. His new appointment, which he takes up at the beginning of 1947, will give him the opportunity to build up a school of research workers in this interesting and important field.

University of London: Appointments

THE following appointments recently made by the University of London have been announced: Dr. Frank Dickens, during 1933–46 research director for the North of England Council of the British Empire Cancer Campaign, to the Philip Hill chair of experimental biochemistry tenable at the Middlesex Hospital Medical School as from March 1, 1946; Dr. J. F. Danielli, during 1942–45 research fellow and supervisor in physiology at St. John's College, Cambridge, to the University readership in cell physiology, tenable at the Royal Cancer Hospital as from October 1, 1946; Dr. J. L. D'Silva to the University readership in physiology tenable at St. Bartholomew's Hospital Medical College, where he has been lecturer in physiology since March 1944; Dr. J. M. Robson, senior lecturer in pharmacology in the University of Edinburgh, to the University readership in pharmacology tenable at Guy's Hospital Medical School as from October 1, 1946. The title of reader in applied entomology in the University of London has been conferred on Dr. A. B. P. Page in respect of the post held by him at the Imperial College of Science and Technology.

University of Glasgow: Appointments

THE following appointments have been made in the University of Glasgow: John E. Parton and Douglas S. Gordon to be lecturers in electrical engineering, and A. J. O. Cruickshank as an assistant; John S. Macpherson, W. A. Donaldson and D. D. McKinnon to be assistants in mathematics; and Robin Giles as an assistant in natural philosophy.

University College, Hull: Appointments

UNIVERSITY COLLEGE, Hull, has made the following promotions and appointments in the Faculty of Science: Paul G. 'Espinasse to be professor of zoology; R. D'O. Good to be professor of botany; Dr. B. Jones to be G. F. Grant professor of chemistry in succession to Prof. F. G. Tryhorn; Dr. B. T. Cromwell to be reader in botany; Miss M. A. Tazelaar to be lecturer in zoology The following have been appointed assistant lecturers: J. W. F. Bell (physics), D P. Brachi (geography), Dr. A. Cunliffe (physics), Miss L. R. Latham (geography), Mrs. H. Neumann (mathematics), E R. Trueman (zoology), J. Webster (botany). A. Saville has been appointed research biologist in the Department of Oceanography.

Announcements

THE following appointments have recently been made by the Colonial Office: A. B. Briars, to be agricultural officer, Nyasaland; J. F. Graham, to be supernumerary entomologist, East African Locust Directorate, Kenya; A. D. T. Montague, agricultural officer, Gold Coast, to be senior agricultural officer, Gold Coast; R. O. Roberts, geologist, Uganda, to be chemist and petrologist, Uganda.

MR J. A. YOUNG has been appointed assistant agricultural adviser to the High Commissioner for the United Kingdom in Canada, and will be stationed at Ottawa. He will assist in that capacity Mr. A. N. Duckham, the agricultural adviser to the High Commissioner, who is also the agricultural attaché at the British Embassy in Washington. Mr. Young was educated at Dungannon Royal School and Queen's University, Belfast, where he obtained the degree of B.Agr., with distinction. After leaving the University he was appointed to the inspectorate of the Ministry of Agriculture for Northern Ireland and latterly has been mainly engaged on technical and agricultural education work.

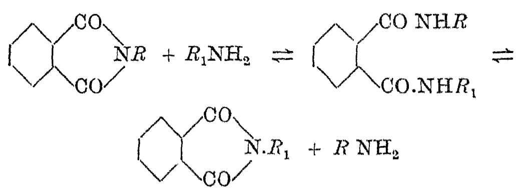
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Composition of the Antimalarial Drug R.63 and the Ing and Manske Hydrazine Hydrolysis of N-Substituted Phthalimides

DURING 1944, we investigated, as part of our antimalarial research programme the structure of the potent antimalarial drug *R* 63[1] The recent publication by Mosher[2] of a further contribution to this subject makes it desirable to report briefly our own results Some of this work forms the subject-matter of a British Patent Application (17071/44, of September 6, 1941) which was placed on the secret list, thus delaying publication. It is clear that Mosher has independently reached the same conclusion as our own, namely, that *R* 63 contains a substantial proportion of *R* 36 (8-γ-aminopropylamino-6-methoxy-quinoline dihydrochloride)

Our preliminary experiments soon indicated that *R* 63 was a complex mixture, and we therefore approached the problem mainly by a study of the reactions involved in its preparation, in preference to attempting a complete analysis of *R* 63 with few clues to the nature of the probable constituents In our preparations of *R* 36 by the hydrolysis of 8-γ-phthalimidopropylamino-6-methoxyquinoline with alcoholic hydrazine hydrate[3], we have found that a secondary product, *bis*-[γ-(6-methoxy-8-quinolylamino)propyl]-phthalamide, is formed in amounts depending on the proportion of hydrazine hydrate used (30 per cent theoretical quantity with 0 8 molecular proportion of hydrazine hydrate) The discovery of this by-product led eventually to the following scheme of reactions between N-substituted phthalimides and amines being established

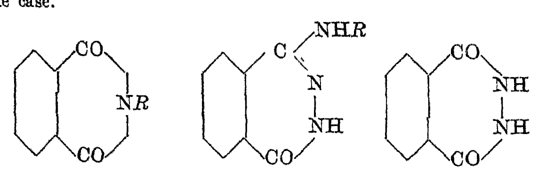


The main factors which determine the end products are the electronic characteristics of *R* and R_1 and such relevant properties as solubility of their derivatives in the reagents used, or volatility at the reaction temperature.

When the penultimate stage of the preparation of *R*.63 (the fusion of 8-γ-aminopropylamino-6-methoxyquinoline and γ-bromopropyl phthalimide) was considered in the light of the above scheme, it was possible to explain such unexpected results as the isolation from the reaction product of some 8-γ-phthalimidopropylamino-6-methoxy quinoline (I)—a result confirmed but not explained by Mosher The isolation of (I) implied the simultaneous formation of the highly reactive bifunctional compound, γ-bromopropylamine, which would immediately undergo self-condensation or react with other components of the reaction mixture Evidence for this view was found in a model experiment in which *n*-propylamine was in fact liberated from *n*-propylphthalimide. Furthermore, unchanged starting materials and some of the required product, 8-γ'-phthalimidopropyl-γ-aminopropylamino-6-methoxyquinoline, were found in the fusion melt At this point, it was clear that the final stage in the *R* 63 preparation (treatment of the crude fusion melt with alcoholic hydrazine hydrate followed by warm dilute hydrochloric acid) could lead to an even more complex mixture of products. We therefore turned our attention to the synthesis for antimalarial test of those impurities likely to be present in *R*.63 as the result of the side reactions brought to light in our work.

The possibility of radical exchange during phthalimidoalkylation reactions used to build up side chains for antimalarial compounds is a factor to be assessed before structure can be assigned with certainty to the products obtained

A further interesting feature which also emerged was the nature of the intermediate formed in the hydrazine hydrolysis of N-substituted phthalimides (II). Ing and Manske[4] tentatively assigned the structure (III) to the product, but did not isolate and characterize it in any one case.



(II) (III) (IV)

We have found that the product is in fact the *salt* of the base, $R.NH_2$, with phthalyl hydrazide (IV), which is a moderately strong acid. The recognition of the nature of this intermediate (foreshadowed by Mosher, *loc. cit.*) shows at once that the subsequent acid hydrolysis is an irrelevant step, and improvements in the method which may widen its application are apparent Thus, the required base can be obtained by thermal dissociation, by solvent extraction or by basification of the intermediate salt An interesting new application of phthalyl hydrazide is the preparation of anhydrous hydrazine by thermal dissociation of the readily accessible hydrazine salt of phthalyl hydrazide[5] Other volatile bases may be treated similarly

A fuller account of this work will appear elsewhere in due course

H J BARBER
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Dagenham, Essex
Sept 18

[1] Robinson and Tomlinson, *J. Chem Soc*, 1524 (1934). Robinson *et al*, *J Chem Soc*, 555 *et seq* (1943)
[2] Mosher, *J Amer Chem Soc*, 1565 (1946)
[3] Baldwin, *J Chem Soc*, 2962 (1929) Magidson and Bobishev, *J Gen Chem*, *U S S.R*, **8**, 912 (1938) Beer, *J Gen Chem*, *U S S R*, **9**, 2158 (1939) Robinson *et al*, see ref 1 Kissinger, Von, and Carmack, *J Amer Chem Soc.*, 1563 (1946). Mosher, see ref 2
[4] Ing and Manske, *J Chem Soc*, 2319 (1926)
[5] Brit. Pat Applic, 27900/46.

Kinetics of Aromatic Nitration : the Nitracidium Ion

THE kinetic studies described in the first of these communications* lead to the conclusion that the nitracidium and nitronium ions, $H_2NO_3^+$ and NO_2^+, are successively formed during nitration by nitric acid, but that only the nitronium ion, NO_2^+, is effective for nitration in anhydrous or nearly anhydrous acid This note offers evidence for the effectiveness, under other conditions, of the nitracidium ion, $H_2NO_3^+$, as a nitrating agent

We should expect to be able to provide such evidence, if at all, only by operating in aqueous media For it has been shown that in anhydrous nitric acid, as well as in other anhydrous strong acids, any $H_2NO_3^+$ formed is largely or completely dehydrated to NO_2^+, and we can be certain that, whenever any appreciable quantity of NO_2^+ is present, it, rather than $H_2NO_3^+$, will be the effective agent for nitration.

We have accordingly pursued the study of nitration kinetics into the range of media in which the main constituent is water, though the concentration of nitric acid has to be such that this substance is largely present as molecules, and not almost wholly as nitrate ions Under these conditions nitration is invariably (within our experience) a reaction of the first order with respect to the aromatic compound ; comment on this is made below Further, the reaction is accelerated by added strong acids, such as perchloric or sulphuric acid : this shows that the nitric acid molecule itself is not the nitrating agent, and that a proton uptake must in some way be involved. Finally, nitration is retarded by added nitrate ions, and this is not a primary salt effect. All these results point to the formation of the nitracidium ion in pre-equilibrium,

$$2HNO_3 \rightleftharpoons H_2NO_3^+ + NO_3^-,$$

and they are consistent with the hypothesis that this ion is the nitrating agent.

The kinetic results do not rigorously exclude the possibility that the nitracidium ion is further converted into the nitronium ion, and that the latter is the nitrating agent There are, however, two arguments against this interpretation. One is that our knowledge of the properties of the NO_2^+ ion make it very difficult to believe that any trace of it could exist in a medium containing 70 mol. per cent of water The other is that, if the NO_2^+ ion were an intermediary, we might have hoped to observe a zeroth-order reaction, for which, actually, we have made a prolonged but unavailing search. We have evidence that the nitracidium ion may also become the effective agent for the *N*-nitration of amines[1]

The main series of experiments have been carried out with sodium toluene-ω sulphonate Because of the small nitrating power of solutions such as those here used, it is necessary to employ reactive aromatic compounds, which must, moreover, be soluble in water. Phenol and aniline derivatives had to be avoided, because special complications are liable to arise in these cases.

E. S. HALBERSTADT
E. D. HUGHES
C. K. INGOLD

Sir William Ramsay and Ralph Forster Laboratories,
University College, London.
Sept. 2.

* *Nature*, **158**, 448 (1946).
[1] Unpublished investigations with J. Glazer.

Nitration of Phenol and Aniline Derivatives : Role of Nitrous Acid

WHILE nitrous acid (we include in this term all material that with water gives nitrous acid) is a negative catalyst in aromatic nitration generally, it has often been found to be a positive catalyst in the nuclear nitration of phenol and aniline derivatives. New experiments, mainly with phenol derivatives, have lessened the contrast by showing that, in the nitration of these substances, both positive and negative catalysis may be encountered in different ranges of nitric acid concentration, and that the negative catalysis is quite similar to that appearing in the nitration of aromatic compounds of other types. Nevertheless it is clear that certain special mechanisms, dependent on nitrous acid, intervene in the nitration of phenol and aniline derivatives, and we have been attempting to throw some light on their nature by a study of the kinetics and products of the nitration of these compounds.

The following is a composite kinetic picture based on studies with phenol, *o*- and *p*-nitro- and 2 4-dinitro-phenol, anisole, *p*-cresyl methyl ether and diphenyl ether, mainly in acetic acid as solvent. Parts of the pattern become repressed, and other parts accentuated, for aniline derivatives. For fixed concentrations of nitrous acid, an increasing concentration of nitric acid at first retards, then strongly accelerates, and then retards reaction, the final phase setting in the earlier the higher the nitrous acid concentration. For fixed concentrations of nitric acid, an increasing concentration of nitrous acid at first strongly accelerates, then retards, and then weakly accelerates nitration, the retardation setting in the earlier the higher the concentration of nitric acid. These statements apply to the general conditions investigated, in which the concentration of nitrous acid was shown to remain constant during nitration

The detailed presentation and analysis of these relations would be lengthy, but we may state our conclusions They are, first, that nitric acid is doing three things it is producing a strong nitrating agent (NO_2^+), it is converting the aromatic compound into a nitration-resisting oxonium ion, and it is helping nitrous acid to suppress NO_2^+ (by converting N_2O_4 into ions, in particular nitrate ion, as described in the first of these communications*) Secondly, nitrous acid is also doing three things it is uniting with the phenol derivative to form a complex, which is highly reactive in nitration, it is, as already mentioned, co-operating with nitric acid to produce nitrate ion and thus to suppress NO_2^+, and, in the form N_2O_4 (or $2NO_2$), it is itself acting as a direct nitrating agent

We think the complex may depend on univalent electron exchange[1] Veibel[2] has already postulated an addition complex between phenol and nitrous acid Arnall[3] has previously assumed direct nitration by N_2O_4.

With phenols, especially in aqueous solvents containing much nitrous acid, yet another mechanism enters, which has been considered before[2,4], namely, nitrosation with subsequent oxidation. Our main evidence of this is that whereas phenol on nitration in water in the presence of as little nitrous acid as possible (PhOH = 1, HNO_3 = 1, HNO_2 = 0 mol) yields *o*- and *p*-nitrophenols in the approximate proportions 7 3, in the presence of a large amount of nitrous acid (for example, PhOH = 1, HNO_3 = 1, HNO_2 = 2 mol) the ratio becomes changed to 1 9, and this is the ratio in which *o*- and *p*-nitrosophenols are formed if the nitric acid is omitted[2] *p*-Nitrosophenol has been isolated as a by-product from the latter nitrations

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Organic Nitrogen Compounds as Nitrogen Nutrition for Higher Plants

IN sterile cultures pea and clover use especially well aspartic and glutamic acids for their nitrogen nutrition, as demonstrated by previous experiments in this laboratory[1]. Both the optical forms are utilized[2] If the nutrient solution contains aspartic acid as well as nitrate and ammonium sulphate, all these nitrogen sources are utilized simultaneously (see accompanying table) Aspartic acid thus competes with nitrate and ammonium nitrogens as a nitrogen source for peas, an important fact to be borne in mind when discussing the ability of plants to utilize organic nitrogen in natural conditions. Nitrogen nutrition has a marked effect on the structure of pea roots. Peas grown on nitrate nitrogen and without nitrogen form in this respect a special group, peas grown on aspartic acid nitrogen, on ammonium nitrogen and on nitrogen supplied by root nodules another.

Furthermore, we have confirmed the earlier observations that when the pea uses aspartic acid for its nitrogen nutrition, nitrogen and carbon disappear from the solution in the same proportion[3] and that no essential change occurs in the *p*H of the solution and no ammonia can be detected in the nutrient solution. In aspartic acid the ratio of carbon to nitrogen is 3 43; in the nutrient solution which originally contained 50 mgm aspartic acid nitrogen and at the end of the experiment 16·6 mgm. nitrogen (all the remaining nitrogen being amino nitrogen) the amount of organic carbon was 57 8 mgm.; accordingly the ratio C/N = 3·48. The position was the same, when the nutrient solution contained besides aspartic acid also nitrate. The ratio of C to NH_2–N in the nutrient solution was thereby likewise 3 48. The results confirm the previous investigations of this laboratory which were interpreted by assuming that the whole aspartic acid molecule is being utilized. Not until it reaches the root cells does the transformation of aspartic acid take place (through deamination, transamination, etc)

With plants of the family Gramineæ (wheat and barley as test plants) aspartic and glutamic acids do not function as N-source according to the previous findings of this laboratory[1]. The entirely different behaviour of legumes and non-legumes towards amino dicarbonic acids is especially noteworthy since certain other amino-acids, for example, α-alanine and glycocol, are utilizable also by wheat and barley In our new experiments, very similar results have been obtained as in the previous ones In one experiment the wheat grown in different nitrogen nutrition media contained the following amounts of nitrogen. without nitrogen nutrition 3 2 mgm, on aspartic acid 2 9 mgm, on glutamic acid 3 3 mgm, on nitrate 22·2 mgm, on glycocol 10 5 mgm, on α-alanine 6 8 mgm, on cystine 7 6 mgm The amount of nutrient solution was in all experiments 20 mgm per plant Some other amino-acids were taken up in certain degree, but in spite of that no growth occurred which would have resulted in the rise of dry matter yield Aspartic and glutamic acids which in some experiments were taken up in very small amounts, 1–2 mgm nitrogen per plant, lower appreciably the dry weight of plants Evidently they accelerate respiration. Since the transamination takes place in Gramineæ as easily as in leguminous plants (our results in this respect are in good agreement with those of Cedrangolo and Carandante[4]), the ineffectiveness of aspartic and glutamic acids is difficult to explain

Moreover, it has been noted that if the wheat is given in sterile nutrient solution besides aspartic acid also nitrate and ammonium sulphate (each providing 22 mgm. nitrogen, total nitrogen supply per plant 66 mgm) the wheat does not grow. The cause for this is being investigated

Regarding the utilization of amino-acids other than aminodicarbonic acids by leguminous plants it may be mentioned that the utilization of glycocol by pea is noticeably good α-Alanine is utilized to a certain extent, but it often causes a curious branching and shortening of internodes The growth of pea is comparatively good on hydrolysed casein (HN_3 removed) and Witte pepton.

In the light of our laboratory experiments, especially the new ones regarding the favourable competition of some amino-acids with nitrate and ammonia nitrogen, it seems probable to us that in natural conditions plants use also organic nitrogen compounds for their nitrogen nutrition, at least in certain soils As a rule, however, the uptake of organic nitrogen by cultivated plants is not great, since ammonium salts and nitrates are rapidly formed from organic nitrogen compounds in soil. Since, however, the uptake of organic nitrogen compounds even in small amounts may affect the plants markedly, the significance of these nitrogen compounds can be great. In the foregoing, alanine has been noted to cause pronounced changes in the shape of pea, and phenyl ethylamine, the decarboxylation product of phenylalanine, which has been added to nitrate-containing nutrient solution, has produced a branching of different type in pea Effects of this kind can be expected to occur under certain conditions also in Nature.

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Botanical Origin of Tube-Curare

dextro-Tubocurarine chloride was first isolated in crystalline form from native tube-curare[1]. It has since become a valuable adjunct in anæsthesia[2]. The chemical constitution of *dextro*-tubocurarine chloride and its relation to bebeerine[3] suggests that its botanical origin lies in some species of *Chondrodendron*. Through the kindness of Mr. J. W. Massey, British consul in Iquitos, the stem and leaves of *Chondrodendron tomentosum* Ruiz and Pavon, collected by the late Guillermo Klug at Tarapoto in Peru, have been made available. The leaves were identified by Mr N. Y. Sandwith of the Herbarium, Kew, as belonging to this species, and on chemical examination the stems yielded *lævo*-curine (*l*-bebeerine) and *lævo*-tubocurarine chloride The latter was found by Dr. B D. Burns to have a curare action on the rat's diaphragm, which was very weak when compared with that of *dextro*-tubocurarine chloride

On the other hand, Dutcher[4] has examined a native Upper Amazonian curare prepared from *Ch tomentosum* and has isolated *dextro*-tubo-

TORSDAG-PEA GROWN ON DIFFERENT N-NUTRITION IN STERILE WATER CULTURES. ONE PLANT IN EACH FLASK CONTAINING 1 l NUTRIENT SOLUTION. STERILE PLANTS WERE TRANSFERRED TO CULTURE FLASKS JANUARY 19–21, 1946

Quality of N-nutrition Amount of N-nutrition, N (mgm)	$(NH_4)_2SO_4$ + $Ca(NO_3)_2$ + Aspartic acid 50 + 50 + 50 = 150				$Ca(NO_3)_2$ + Aspartic acid 50 + 50 = 100				$(NH_4)_2SO_4$ + Aspartic acid 50 + 50 = 100	
Number of days N-nutrition given	14	22	28	35	14	22	28	35	22	38
Dry weight of plant (mgm)	919	1789	2589	2987	857	1989	1823	2792	487	688
N in plant (mgm.)	48·3	86 6	108 7	118 9	38 9	61·2	49 8	64 3	27·9	42·4
N in % of dry matter	5 2	4 9	4 0	4 0	4·5	3·1	2·7	2 3	5·7	6·2
Final *p*H of the nutrient soln.	6 1	6 1	6 5	6·8	6·9	6 9	7 5	7 4	6·3	6·0
NO_3—N used (mgm)	10 8	23·1	25 8	26 0	19·6	33·1	26 2	37 4		
NO_3—N in % of total N used	22 8	28 6	24 2	22·4	55 7	61·1	54 8	63 7		
NH_4—N used (mgm.)	16 5	31·5	40 8	49·0					13·6	21·2
NH_4—N in % of total N used	34 9	39·1	38 2	42·1					69 4	53·1
NH_2—N used (mgm.)	20 0	26 0	40·0	41·3	15 6	21 1	21 5	21 3	6·0	18·7
NH_2—N in % of total N used	42·3	32 3	37·6	35 5	44 3	38 9	45·2	36 3	30·6	46·9
Total used N (mgm)	47 3	80·6	106 6	116 3	35 2	54 2	47 7	58 7	19·6	39·9

curarine chloride, *lævo*-curine and other non-quaternary bases. It therefore seems that the species named *Ch. tomentosum* may include two hitherto undifferentiated species needing the attention of the systematic botanist

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Molybdenum-Thiocyanate Complex

WHEN stannous chloride is added to an acid solution containing molybdenum and an alkali thiocyanate an orange coloration appears. This reaction has been applied as the basis of methods for the determination of molybdenum in steels[1,2,3], soils[4], rocks[5], and plant materials[6].

The reaction was first observed by Braun[7], who gave some indication of the sensitivity of the test and noted also that the coloured complex was freely soluble in ether and could, therefore, be concentrated in this solvent.

We have investigated this reaction for the determination of small amounts of molybdenum in biological material, and the details of the modifications we have introduced will be published elsewhere. However, in the course of the investigation we have found that the density of colour developed from a fixed amount of molybdenum is dependent upon the presence of iron in the solution.

If a colour density/molybdenum concentration curve is constructed from transmission readings on extracts of the coloured complex in iso-amyl alcohol, which we found to be the most satisfactory solvent, it is seen that a straight line relationship is not obtained when the extracts are first prepared. If, however, further readings are taken after the extracts have been standing in open tubes for some time, the density/concentration curve progressively approaches linearity, until after a period of some ten days or so the colour density is directly proportional to molybdenum concentration. These results are illustrated in Fig. 1.

On the other hand, if sufficient iron is present in the aqueous molybdenum solution, there is no intensification of the colour as was observed in the absence of iron. The density of the colour is proportional to the molybdenum concentration immediately the extracts are prepared, and the colour remains stable over long periods.

If the coloured complex is developed from a fixed amount of molybdenum in the presence of varying amounts of iron, one finds that the colour density is greater with increasing amounts of iron until a certain minimal quantity of iron has been added, and then remains practically constant. This effect is shown in Fig. 2, which records the results of three experiments at three different levels of molybdenum, and it will be seen that the amount of iron required for full colour development increases as the amount of molybdenum present increases. We found that 10, 20 and 30 μgm. of molybdenum require 6, 12 and 18 μgm. of iron respectively for full colour development. That is, one gram atom of iron is required for each gram atom of molybdenum.

However, although the presence of iron intensifies the colour it does not modify the nature of the colour, for spectral absorption curves in the presence and absence of iron are identical.

A quantitative study shows that the density of the colour produced from a given amount of molybdenum per cent in the absence of iron is approximately 65 per cent of that produced when adequate iron is present. It seems probable, from the above observations, that the complex molecule consists of a chromogenic and a non-chromogenic part and that, in the absence of iron, some of the molybdenum is present in each part of the molecule. We suggest that the action

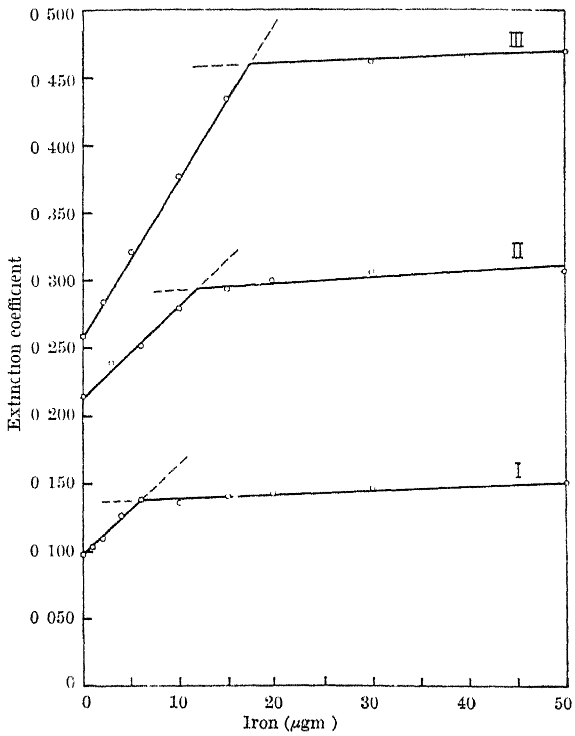

Fig. 2

of iron is to replace the molybdenum in the non-chromogenic part of the molecule, and we would formulate the complex, under the two conditions, as follows:

In the absence of iron $Mo_2\,[MoO(CNS)_5]_3$
In the presence of iron $Fe\,[MoO(CNS)_5]$

In a study of the properties of the molybdenum thiocyanate complex in aqueous solution, Hiskey and Meloche[8] conclude that the molybdenum in the coloured complex is quinquevalent, that the ratio of thiocyanate to molybdenum is 3 : 1, and that tervalent molybdenum does not form a red-coloured thiocyanate. The above formulation is in accord with all these observations. If only that portion of the complex within the square brackets is regarded as chromogenic, then the molybdenum is quinquevalent, that outside the bracket is tervalent and non-chromogenic. This formulation also allows for the observed one third intensification of the colour when all the molybdenum is moved into chromogenic part of the molecule as in the presence of iron.

Recently, Shashkov[9] has published some findings on the nature of the molybdenum-thiocyanate complex in aqueous solution. He found that the slope of the colour density/molybdenum concentration curves varied for different ranges of molybdenum concentration and suggested that the complex formed with the lower concentrations was different from that formed with the higher. It is probable that Shashkov's two complexes correspond to those formulated above. If his reagents contained traces of iron, then the intensification due to the formation of the iron-containing complex would increase the slope of the density/concentration curves at the lower concentrations of molybdenum but would have little effect in the higher concentrations, as only a small proportion of the total coloured complex would be in the iron-containing form.

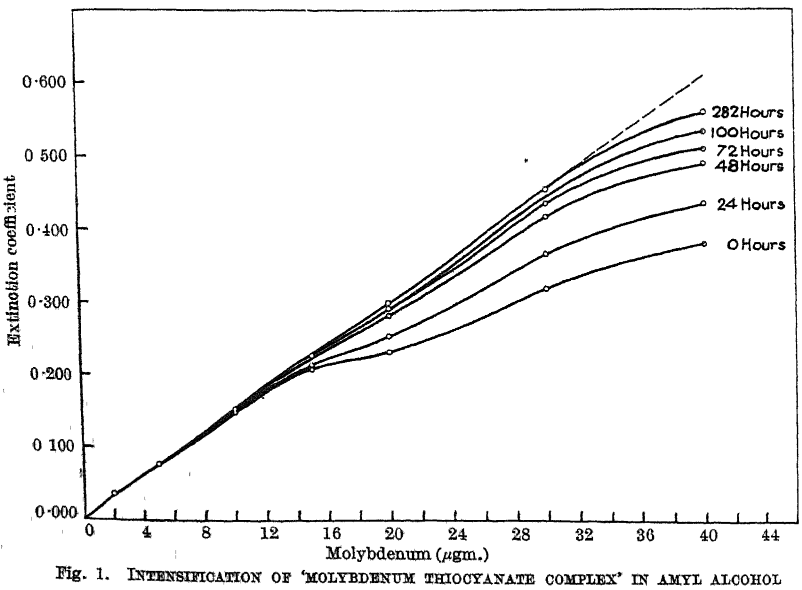

Fig. 1. INTENSIFICATION OF 'MOLYBDENUM THIOCYANATE COMPLEX' IN AMYL ALCOHOL

Of eighteen other elements investigated, namely, sodium, silicon, potassium, calcium, titanium, vanadium, copper, chromium, manganese, cobalt, nickel, zinc, arsenic, silver, tin, antimony and mercury, copper alone had any similar effect. Curves constructed showing the effect of varying amounts of copper on the colour density with a fixed amount of molybdenum were similar in form to those represented for iron. The points of inflexion corresponded to a ratio of 3 gm. atoms of copper for every 4 gm. atoms of molybdenum, showing that rather less copper than iron is needed to effect full colour development.

We feel that attention should be directed to these observations since any procedure for the determination of molybdenum by the thiocyanate method, which compares the colour produced in the sample, which may contain adequate iron, with that obtained from a standard solution of molybdenum to which no iron or copper has been added, must give high results. This can readily be obviated by the addition of sufficient iron or copper to both standard and sample

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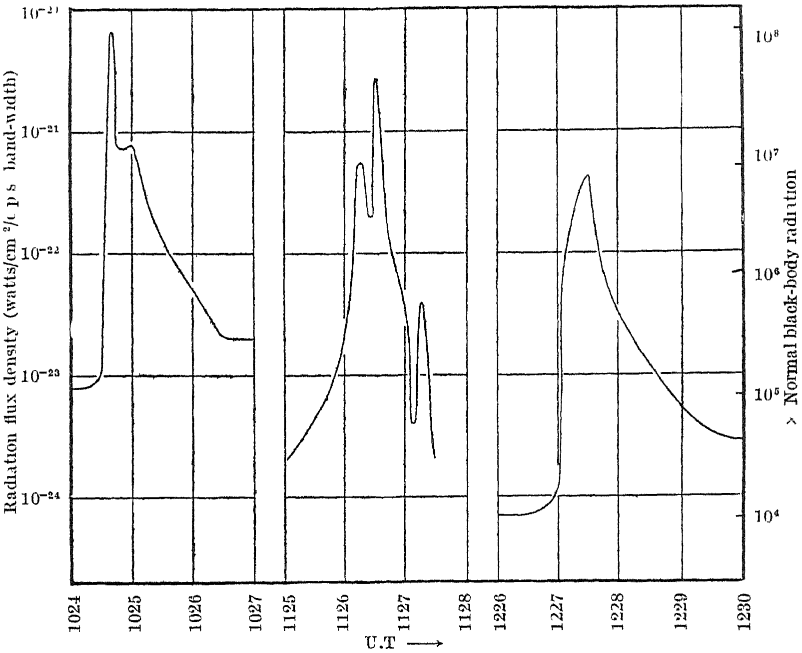

Fig 2. SHORT-PERIOD PEAKS ON AUGUST 2

Details as for Fig 1

Abnormal Solar Radiation on 72 Megacycles

THE suggestion that the sun emits energy at a rate in excess of the black-body value on radio wave-lengths during periods of sunspot activity has been made by Appleton[1]. Experimental evidence of this effect has been obtained by Hey[2], and Pawsey, Payne-Scott and McCready[3] Details are given here of measurements of the intensity of some extremely large increases of radiated solar energy on 72 6 Mc./s. observed during July and August 1946. The equipment was not primarily designed for measurements of solar radiation and was engaged on other experiments using a vertically directed aerial system In calculating the solar radiation intensity, allowance has therefore been made for the polar diagram of the aerial system and the position of the sun.

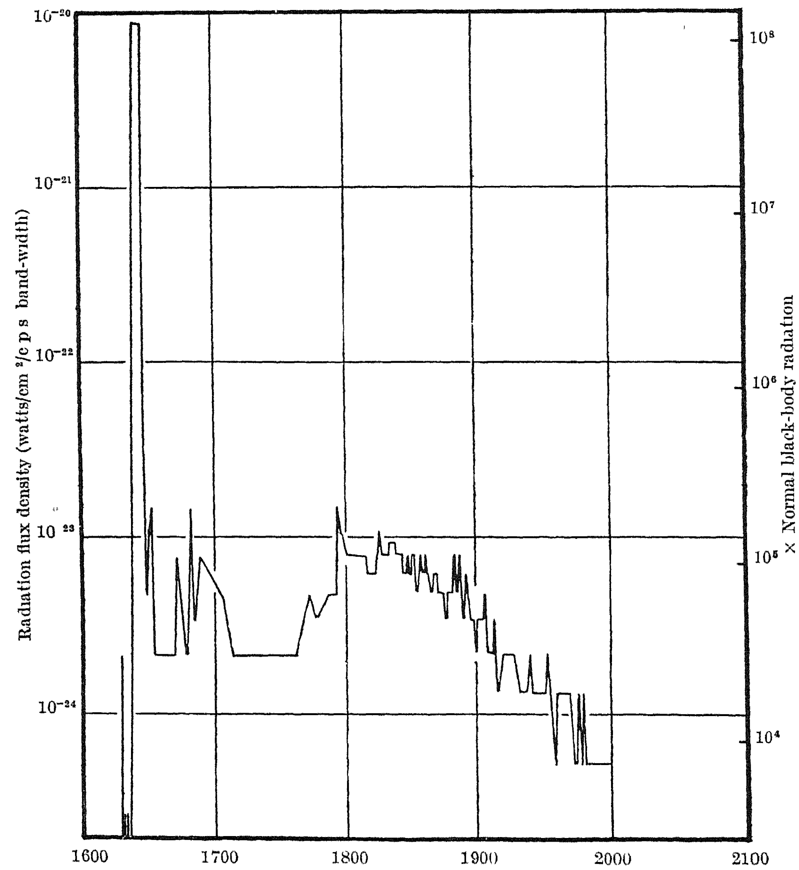

Fig. 1. SOLAR RADIATION ON 72 6 Mc /s ON JULY 25

Polarization of aerials horizontal; elements of aerial, north – south; point of observations, lat. 53° 13′ 53″ N., long 2° 18′ 11″ W.

At this frequency the flux density of black-body solar energy between frequencies f and $f + \Delta f$ received at the earth's surface is given by[1]:

$$F = \frac{2\pi kT}{\lambda^2}\left(\frac{r}{R}\right)^2 \Delta f \,\text{ergs/cm.}^2\text{/sec.},$$

where r is the sun's radius, R the earth-sun distance, k Boltzmann's constant and T the effective solar temperature. If this energy is received on an aerial of power gain G over a half-wave dipole, the equivalent collecting area is approximately $G\lambda^2$ 8, and the solar black-body radiation will give a power p_s at the receiver where:

$$p_s = 0{\cdot}4\,G.k.T.\left(\frac{r}{R}\right)^2 \Delta f \,\text{ergs/sec.}$$

In the present equipment, $G = 7\ 8$, and the band-width of the receiver $\Delta f = 2{\cdot}5 \times 10^5$ c.p.s. Hence, if $T = 6{,}000°$ K., $p_s = 1\ 4 \times 10^{-13}$ watts (corresponding to a radiation intensity of $6\ 5 \times 10^{-25}$ watts/cm ^{2}/c.p.s. (band-width)

The normal noise-level of the receiver corresponded to a power input p_r of $2{\cdot}7 \times 10^{-14}$ watts (equivalent to a radiation intensity of $1{\cdot}25 \times 10^{-24}$ watts/cm.^{2}/c.p.s. band-width) Hence an increase of solar energy of $1{\cdot}9 \times 10^4$ over its black-body value would be necessary before the effect became noticeable. This level was exceeded over a considerable period, and at one stage the solar radiation intensity reached $8\ 6 \times 10^{-21}$ watts/cm.^{2}/c.p s. band-width, that is, $1\ 3 \times 10^8$ times the normal black-body value.

The main events, which occurred on July 25 and August 2, 1946, are plotted in Figs 1 and 2 respectively The left-hand ordinate gives the measured solar radiation flux density in watts/cm ^{2}/c p s band-width, and the right-hand ordinate the factor by which this exceeds the normal black-body radiation on this frequency The very large surge of energy at 1624 U T on July 25, which exceeded 10^8 times black-body radiation, was followed by abnormally high noise throughout July 26–27, fluctuating between 6×10^{-23} and 8×10^{-25} watts/cm ^{2}/c p s band-width On July 28 the radiation had fallen below the minimum value detectable by our apparatus except for occasional minor surges Unfortunately, a prolonged thunderstorm began at 1200 U T on July 26 and caused disturbances which may have obscured some of the solar radiation maxima during the rest of that day. On August 2 three large surges were observed, each lasting for about two minutes In the intervening periods between these surges the solar radiation was below the minimum detectable by our equipment These surges were plotted automatically by a pen recorder and their detailed structure is reproduced in Fig 2

In addition to these main events, other appreciable surges of energy were recorded on July 22, 24 and 25 These are detailed in the accompanying table No other significant increases of radiation were noticed between July 22 and August 14, although observations were not continuous throughout the period, and the possibility that other surges occurred cannot therefore be excluded

Date	Time (U T)	Remarks	Radiation flux density in watts/cm ^{2}/c p s band-width	Ratio to black-body value
July 22	1629–1642	Several surges	$5\ 0\times10^{-24}$	$7\ 7\times10^4$
July 24	1628	3 surges each of a few seconds duration	$5\ 0\times10^{-24}$	$7\ 7\times10^4$
July 25	1031 30	Surge approx 1 sec. duration	$3\ 8\times10^{-23}$	$5\ 8\times10^5$
,,	1032	,, ,,	$3\ 8\times10^{-23}$	$5\ 8\times10^5$
,,	1434	Surge approx 2 sec duration	$5\ 6\times10^{-23}$	$8\ 6\times10^5$
,,	1435.30	Surge approx. 0 5 sec. duration	$5\ 4\times10^{-24}$	$8\ 3\times10^4$
,,	1437.30	,, ,,	$5\ 4\times10^{-24}$	$8\ 3\times10^4$

The main event, beginning at 1624 U.T. on July 25, would appear to be closely associated with the intense solar flare which began at 1600 U.T. on that date and, according to Ellison[4,5], reached its peak brilliance at about 1627 U T. The peak value in the solar energy of $1{\cdot}3\times10^8$ times black-body value lasted from 1624 until 1627.30 U.T Surges of almost identical magnitude associated with solar flares were found by Appleton and Hey during the large sunspot of February 1946 These results (in publication, *Phil Mag*) have been communicated privately.

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Use of Lead Sulphide Photo-conductive Cells for High-speed Pyrometry

LEAD sulphide photo-conductive cells were first manufactured during the War in Germany by Gudden, Kaspar, Kutzscher and others, though details have not yet been published. In late 1944 work on these cells was begun in Great Britain, and methods of manufacture were developed at the Admiralty Research Laboratory. This work will be described elsewhere. It is the purpose of this note to emphasize the value of these detectors for the measurement of rapidly varying surface temperatures, a problem which often arises in physical and engineering laboratories.

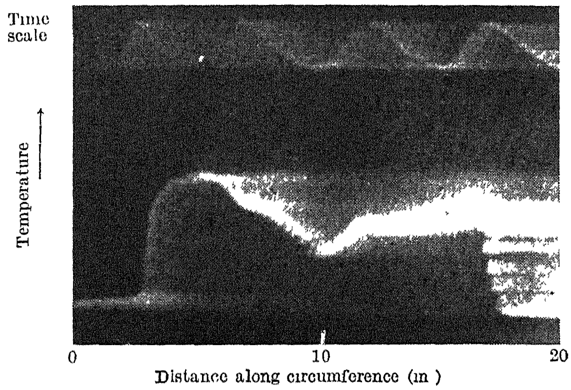
The cells are usually sensitive in the visible region of the spectrum, but the peak response lies in the infra-red region at 2 7 microns and the long-wave threshold is near 3 5 microns. An average cell of area 10 sq mm, used at normal temperatures in conjunction with a radiation chopper and a tuned amplifier of response time 30 milliseconds, gives a signal equal to noise with 10^{-9} watts of radiation falling on it of wave-length between 1 and 3 microns. The response time can be decreased at the expense of sensitivity by increasing the amplifier band width The response time of the cells themselves is of the order of 0 1 millisecond.

The radiation in the region 1–3 microns emitted by a black body at various temperatures is given below.

Temp ° C.	100	200	400	600	800
Watts/cm ^{2} emitted (1–3μ)	$1\ 2\times10^{-4}$	$2{\cdot}4\times10^{-3}$	$7\ 9\times10^{-2}$	$5\ 5\times10^{-1}$	2 35

It will be seen that there is sufficient radiant energy available for pyrometric measurements of reasonable accuracy at temperatures as low as 100° C Surfaces which are not black will, of course, give correspondingly reduced signals, and constancy of surface conditions is required for accurate temperature measurement

Cells made at the Admiralty Research Laboratory have been applied successfully to problems of this kind In particular, the determination of temperature changes taking place along the circumference of a 36-in diameter railway wheel when subject to service braking from speeds up to 60 m p h is being made at Messrs. Ferodo Limited, Chapel-en-le-Frith Radiation from a 5 sq mm. area of tyre falls on to the cell via an arrangement which comprises a water-cooled copper sighting-tube and a rotating slotted disk which serves as the radiation chopper After amplification the signal is fed to one beam of a Cossor double beam C R O, while the other beam registers small angular deflexions of the wheel and a 50-cycle time trace. The amplifier employed, which was very kindly loaned by the Telecommunications Research Establishment, Malvern, has a response time of 1 millisecond Deflexions of the beams are recorded by a moving film camera and so give variations of the temperature along the tyre circumference as the wheel decelerates Calibration is effected by focusing the cell on a small cylinder of tyre material contained in a specially designed vacuum furnace, care being taken to match the optical paths and the surface condition of the metal



A short length from a typical record is shown in the accompanying figure The maximum temperature in this example corresponds to about 400° C., and it would appear that part or the whole of the tyre area viewed by the cell was in close contact with the brake for this limited period of the deceleration In this equipment temperatures from 150° C to 950° C. are covered in two ranges. The accuracy of measurement, which is determined by the width of the trace, is between 5° C. and 25° C, depending on the range of temperature covered. The nature of the variations of temperature over the surface will be discussed in a further publication.

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Absorption Spectrum of Trithioformaldehyde and Thiometaformaldehyde

THE ultra-violet absorption spectrum of formaldehyde has been investigated by various workers and is now well known. In an attempt to investigate the corresponding spectrum of monomeric thioformaldehyde, the ultra-violet absorption of gaseous trithioformaldehyde and thiometaformaldehyde at temperatures up to 250° C has been examined. Using silica tubes up to 50 cm in length, no band spectrum was observed, absorption being continuous from 2739 5 A to the lower range of observation, the intensity and extension of the absorption increasing gradually with the temperature

The ultra-violet absorption spectra of saturated solutions of trithioformaldehyde and thiometaformaldehyde in chloroform, ethyl alcohol, sulphuric ether and carbon tetrachloride did not show any dependence on the nature of the solute, except for chloroform in which the absorption of the trimer started at a somewhat higher wave-length than the absorption in the meta solution.

A detailed account will be published later.

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Feeble Paramagnetism of Hexavalent Chromium

FEEBLE paramagnetism[1] is exhibited by certain ions in the ^1S state As the spin quantum number in this case is zero, van Vleck[2] suggested that there remains only the contribution of the high-frequency elements of the orbital moment, as given by the second term in the formula:

$$\chi_{\mathrm{mol}} = -\frac{Nc^2}{6Mc^2}\Sigma\bar{r}^2 + \frac{2}{3}N\sum_{n'\neq n}\frac{|M^0(n'\,;\,n)|^2}{h\nu(n'\,;\,n)}.$$

The calculations of the two parts of the above formula, however, have been carried out only for the hydrogen molecule The results indicate that the orbital paramagnetism in general has a very low value and may not form a basis for satisfactorily explaining feeble paramagnetic effect An attempt has therefore been made to suggest another source for the paramagnetism shown by the ions in the ^7S state.

In compounds containing hexavalent chromium such as chromium trioxide and potassium chromate, the bond between chromium and oxygen is not fully ionic but partially covalent in nature[3]. The covalency consists of sharing of electrons between chromium and oxygen, and evidently, so far as the electronic effect in chromium is concerned, the spin may be considered as unpaired The partial freedom of the spin due to imperfect pairing thus accounts for the fractional paramagnetic effect exhibited by Cr^{+6}

Assuming that electronic charge distribution is spherical, structure diagrams were constructed on the basis of X-ray data[3,4] and ionic radii[5] for chromium trioxide and potassium chromate, and the total unpaired spin was calculated. The factor for the unpaired spin in both is 1/16 The values for the paramagnetism of the trioxide and potassium chromate calculated using this factor, after allowing for the diamagnetic effect, agree well with the values obtained experimentally by Grey and Drakers[1].

The details of this calculation will be published elsewhere

Hexavalent chromium compounds were selected for this study as accurate X-ray[3,4] and magnetic data[1] for these compounds are available Further work is in progress

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Cleavage of Selenite and Mosaic Structure

IN a former publication[1], an account was given of the examination of the topographical structure of a cleavage face of a selenite crystal, use being made of multiple-beam Fizeau fringes Only low magnifications of area were used, yet it was observed that the fringes were extremely ragged, indicative of a complex surface 'fine-structure'.

We have extended these observations further, on selenite from a different source, using multiple-beam Fizeau fringes, and also fringes of equal chromatic order[2], both with up to × 400 linear magnifications, and with high and low dispersions The earlier conclusions concerning the existence of the fine structure have been confirmed and extended. The surface structure is found to consist of a mass of short quite narrow strips, generally oriented more or less parallel to the major long cleavage lines (see ref 1)

These narrow strips are not co-planar but vary slightly in height (depth) from 15 A to perhaps some 800 A. on the particular samples examined The strip width is usually of the order of a tenth of the length. Since some of the observed strip lengths are in the region 0 5–1 5 × 10^{-2} cm, it seems probable that our microscope has failed to resolve many of the narrow strip *widths*

We reproduce in Fig 1 some high-magnification, high-dispersion fringes of equal chromatic order Linear magnification on the original is × 400 Either fringe at λλ 6390 or 5480 respectively can be regarded as a contour of the crystal over the region selected by the spectrograph slit. The separation between orders represents 2730 A, and the various steps in a single fringe are encompassed within a height of 400 A. The vertical traverse across the picture represents 0 1 mm along the crystal surface Attention is directed to the high quality of the definition, the fringe width being quite a small fraction of the order separation

As is clear, the particular section of the surface shown consists of a fairly regular series of alternating up and down steps, often of approximately the same height The individual short features illustrated represent the strip *widths* and vary from 0 03 mm to 0 005 mm. in this particular picture (the strip *lengths* are ten times as great)

Fig 2 shows a traverse of another section with lower magnification (× 100) and about half the wave-length dispersion. A number of the fine-structure cleavage steps have been measured, and a sample of some of the smaller recorded steps can be grouped as follows.

	16	28	48	58	77
	14	29	43		73
	17	28			
	17	31			
	14				
Mean (A.)	15½	29	45	58	75

The lattice spacing for selenite cleavage given by X-ray measurements is 15 A It is quite clear that these mean values are (within the experimental error) respectively 1, 2, 3, 4, 5 × (15 A.). Thus we have established the fact that the fine structure features are strips stepped frequently by only a few integral multiples of the unit molecular layer, at times, in fact, by but a *single* lattice layer

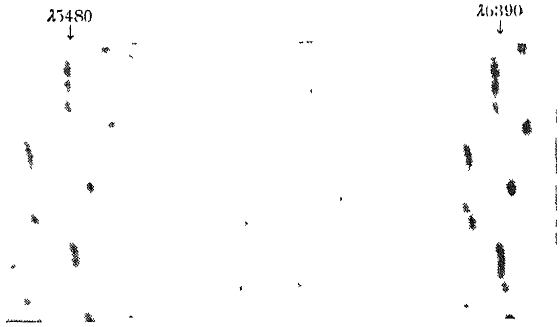

Fig 1

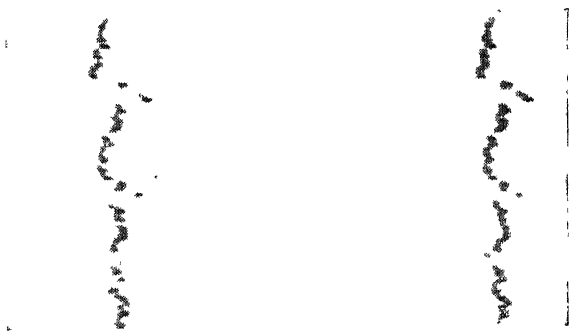
Fig 2

These data seem to afford strong evidence for the existence of some form of mosaic or lineage structure in the selenite If, as was postulated for mica and calcite[3], it can be supposed that cleavage is true to a molecular plane within a perfect crystal, then each simple elementary strip can be considered as a perfect crystal and cleavage is true to a molecular plane in such a unit, but jumping at the boundary to form a step As to the size of such units, they vary considerably in area, from larger than 0 03 mm. × 0 3 mm down to less than 0 005 mm. × 0 05 mm It is not possible to give any indication of the true heights of the units, since clearly cleavage occurs at an arbitrary level and the cleavage steps need not necessarily be the heights of the blocks. Attention may be directed to the fact that, as in mica (despite the smaller lattice spacing), once again it is possible to evaluate an approximate crystal lattice spacing with visible light waves by virtue of multiple beam interferometry.

A more comprehensive report will be communicated elsewhere.

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Useful X-Ray Mutations in Plants

EVER since the discovery of the effect of ionizing radiations on genetic material it has often been questioned whether any mutations of value to the breeder could be produced by such means. This is because there is general agreement among geneticists that individuals with rare mutant genes are usually less balanced, and hence less fit, than the mean of the population Nevertheless it suggests at least one useful application of X-rays—the artificial production of dwarf plants. Such dwarf plants may be useful in fruit trees for precocious root-stocks; and in cherries and pears where this need has not been met from the natural material, X-rays should be the ideal tool for making them. Another useful application is the production of self-compatible plants as explained below.

During the last nine years, many thousands of plants of *Oenothera organensis* have been examined and all have been found to be self-incompatible[1,2]. Furthermore this incompatibility is complete; after self- or cross-incompatible pollination no seed is produced even under the most rigorous conditions Self-compatible plants have been produced, however, by pollinating from flowers which had received an X-ray dose of 500 r. units thirty-seven days previously. The X-rayed plant from which the pollen was obtained and the plant used as the female parent were sister seedlings, both having the constitution S_3S_6 From nineteen flowers pollinated one capsule developed and this contained thirty-six seeds. Thirty-four seeds germinated, giving plants of normal vigour. All were completely self-compatible. In their incompatibility reactions with their parents and with plants having other **S** genotypes these self-compatible plants were of two groups, *A* and *B* The reactions based on pollen-tube growth and seed-set determinations of these two groups of plants are given in the accomplanting table, to help with the interpretation the genetic constitution of the A and B plants are included

Two facts are evident from the first line of the table—both A and B plants are self-compatible and each plant segregates compatible and incompatible pollen in a 1 1 ratio Hence a mutation has occurred giving self-compatibility only to the pollen carrying it, and since the original plant was $\mathbf{S}_3\mathbf{S}_6$ the new allele must have arisen from either $\mathbf{S}_3$ or $\mathbf{S}_6$ or a gene distinct from the $\mathbf{S}$ locus

The second line of the table shows that plants in both groups, when used as male on to the original (unmutated) plant, again have compatible and incompatible pollen in a 1 1 ratio It is not necessary, therefore, for compatibility to have the mutant allele in the style

The reciprocal cross given in the third line of the table shows a striking difference between the two groups. When used as females, plants of group A are incompatible, while plants of group B are compatible with the original plant Two conclusions can be drawn from this (1) that group A plants are heterozygous and group B plants are homozygous for their $\mathbf{S}$ alleles, (2) that the mutant allele does not produce the new 'self-compatibility' effect in the style but produces the same effect as the original allele did before mutation

INCOMPATIBILITY REACTIONS OF MUTANT PLANTS WITH THEIR PARENT ($\mathbf{S}_3\mathbf{S}_6$) AND WITH OTHER GENOTYPES

S_6' is the mutant allele, + +, all pollen compatible, + –, compatible and incompatible pollen in a 1 1 ratio – –, all pollen incompatible

Group A $\mathbf{S}_3S_6'$				Group B $\mathbf{S}_6S_6'$			
$\mathbf{S}_3S_6'$	Selfed or intercrossed		+ –	$\mathbf{S}_6S_6'$	Selfed or intercrossed		+ –
$\mathbf{S}_3\mathbf{S}_6$	×	$\mathbf{S}_3S_6'$	+ –	$\mathbf{S}_3\mathbf{S}_6$	×	$\mathbf{S}_6S_6'$	+ –
$\mathbf{S}_3S_6'$	×	$\mathbf{S}_3\mathbf{S}_6$	– –	$\mathbf{S}_6S_6'$	×	$\mathbf{S}_3\mathbf{S}_6$	+ –
$\mathbf{S}_2\mathbf{S}_6$	×	$\mathbf{S}_3S_6'$	+ +	$\mathbf{S}_2\mathbf{S}_6$	×	$\mathbf{S}_6S_6'$	+ –
$\mathbf{S}_2\mathbf{S}_3$	×	$\mathbf{S}_3S_6'$	+ –	$\mathbf{S}_2\mathbf{S}_3$		$\mathbf{S}_6S_6'$	+ +
$\mathbf{S}_3S_6'$	×	$\mathbf{S}_2\mathbf{S}_6$	+ –	$\mathbf{S}_6S_6'$	×	$\mathbf{S}_2\mathbf{S}_6$	+ –
$\mathbf{S}_3S_6'$	×	$\mathbf{S}_2\mathbf{S}_3$	+ –	$\mathbf{S}_6S_6'$	×	$\mathbf{S}_2\mathbf{S}_3$	+ +

The reactions in the last four lines of the table show that the mutation occurred in an $\mathbf{S}_6$ allele

Since thirty-four plants arose all with the same mutant S_6' allele it is clear that a single mutation occurred at an early stage in the development of an anther and in a nucleus which had at least five mitotic divisions to complete before meiosis

The new allele can be symbolized as S_6', since although it fails to express its activity in the haploid pollen it has the full $\mathbf{S}_6$ activity and specificity in the diploid style. This mutant allele is therefore a hypomorph to the normal allele, and since it has been produced by X-rays this is to be expected But among spontaneous mutations which are known to occur at this locus some would be expected to be neomorphs, that is, new $\mathbf{S}$ alleles with a complete but new incompatibility reaction, since large numbers of different $\mathbf{S}$ alleles are present in natural populations.

That one and not both of the pleiotropic effects of the $\mathbf{S}$ gene has been affected by mutation raises problems of importance in gene structure and gene activity, and these will be discussed together with a full account of the work in a later publication.

It is now clear that self-compatible plants can be produced by X-rays in species which are normally self-incompatible. It is doubtful whether this will be an advantage in seed-reproducing crops where heterozygosity and hence vigour is maintained by cross-pollination In such plants, under conditions unfavourable for cross-pollination, self-compatibility would have the short-term effect of increasing the immediate seed production, but the resulting loss in vigour from inbreeding during a number of generations would offset the initial advantage.

In fruit trees where heterozygosity is fixed by vegetative propagation the advantage of effective pollination under adverse conditions is not offset by loss of heterozygosity.

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[1] Emerson, S H., *Bot Gaz*, **101**, 890 (1940).
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Cytological Basis of High Fertility in Autotetraploid Buckwheat

AUTOTETRAPLOIDS of buckwheat obtained in 1941 by means of colchicine treatment showed variation with regard to fertility[1]. Owing to the vast amount of initial material it was possible to isolate in the variety Bolshevik individuals which were genotypically highly fertile They differed in this respect from other experimentally produced autotetraploids the fertility of which was sharply reduced, some of them being even entirely sterile. Reduced fertility in autotetraploids depends primarily on irregular chromosome distribution in meiosis, leading to the formation of aneuploid micro- and macrospores and consequently to pollen abortion, poor seed setting and to the appearance of polysomics.

In the microsporogenesis of buckwheat autotetraploids during the first metaphase of meiosis only very rarely were exclusively quadrivalents observed, in the majority of cases there were seven quadrivalents and two bivalents At times the number of bivalents was considerably greater as a result of a decrease in the number of quadrivalents. Trivalents and univalents were observed only in plants with reduced fertility. The shape and orientation of quadrivalents on the spindle in autotetraploid buckwheat ensured regular chromosome separation. However, a small amount of irregular distribution was observed in all plants. The most common irregularity was the lagging of one or two chromosomes at the spindle equator, followed by the formation of dwarfed nuclei Far less common was irregular chromosome distribution: 15 and 17 or 14 and 18. The proportion of abortive pollen varied between 2 and 6 per cent; it was higher only in plants with reduced fertility.

In highly fertile plants there were observed extremely small abortive pollen grains containing one or two lagging chromosomes, all the large pollen being good Consequently, pollen grains with aneuploid chromosome numbers $2n - 1$ or $2n - 2$ are viable Hence the possibility of an appearance of polysomics Indeed, polysomics have been discovered, although so far in the progeny of plants with reduced fertility only. They are distinguished by their reduced viability and, with rare exceptions, by complete or nearly complete sterility, a great proportion of their seeds are incapable of germination A hundred per cent germination of the seeds of highly fertile plants is evidence of the absence of polysomics in their progeny

The main source of polysomics is in the progeny of triploids Autotetraploids of buckwheat do practically not cross with diploids Among 986 seeds collected in 1941 from chimeral plants there were found six triploid ones, three of which proved inviable, the remainder were nearly completely sterile Experiments on artificial pollination (658 crosses) furnished negative results The rarity and, possibly, a complete absence of triploids, along with inviability of the majority of aneuploid combinations, make it improbable that a considerable number of polysomics may ever occur in the fields of autotetraploid buckwheat The reduced fertility and nearly complete sterility of the latter would ensure a constant high fertility in autotetraploid buckwheat, and correct breeding work opens wide prospects of a further improvement.

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[1] Sacharov, Frolova, Mansurova, *Nature*, **154**, 613 (1944)

Homostyly of the Flowers of Buckwheat as a Morphological Manifestation of Sterility

BUCKWHEAT is a heterostylic plant, but as early as 1872, Muller described the occurrence in buckwheat, as in other heterostylic plants, of isolated homostylic flowers In *Primula* and in flax, homostylic flowers were said to be morphologically aberrant but functional with increased self-fertility

Our observations have shown that flowers of buckwheat appear to be homostylic in short-styled individuals when stamens are shortened, and in long-styled plants, when the pistil is reduced in size. The anthers of shortened stamens are reduced in size and filled with oval abortive pollen with a thin exine, or contain no pollen whatever

The study of microsporogenesis showed that pollen degeneration was connected with precocious degeneration of the tapetum cells The earlier degeneration of the tapetum begins the stronger is the reduction of stamens. The earliest degenerative phenomena were observed immediately after the completion of meiosis in pollen-mother cells; the meiotic divisions themselves proceeded always normally In these cells there occurs gradual dying of nuclei and of cytoplasm Rudimentary stamens with completely empty rudimentary anthers are formed. When degenerative phenomena set in after the walls begin to be formed around the newly arisen pollen grains, there may be seen within the anther a cellulose plate consisting of adhering pollen-grain walls When stronger walls have already been formed prior to the beginning of degeneration, a somewhat compressed empty pollen is formed. Such pollen is not shed from the anthers. Stamens are somewhat shortened in such cases so as to make short-styled flowers appear to be homostylic It has since been found that such a sterility is more or less frequent in all the diploid varieties of buckwheat

In many flowers reduction in pistils was also found, not only in the style but also in the ovary. This phenomenon was observed both in short-styled and in long-styled plants, it is, however, easier to notice it in the latter When the pistil is shortened to such an extent that the style lies at the level of the stamens or even below, the flowers give an impression of homostyly It has been proved by experiments arranged in the summer of 1945 with diploids of the variety Bolshevik that these presumably homostylic flowers were never fertilized.

Microscopic examination of such pistils has revealed complete degeneration of the embryo sac, of the epithelial cell layer, and also of the cells of the integument. When only the style was shortened the embryo sac was developed normally and fertilization could take place Indeed in such flowers where the stigma is somewhat raised above the level of stamens there was noticed after pollination a slight growth of the ovary, which ceased after a few days. Formation of normal seeds was never observed in these flowers In the case of the presence of rudimentary stamens in short-styled flowers there were observed cases of the formation of normal seeds There were cases of simultaneous reduction of both pistils and stamens

It is clear that homostyly in buckwheat is actually due to sterility based upon genetic factors, while its manifestation may depend upon environment.

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The Coefficient of Variation

TEXT-BOOKS of statistics generally cite the coefficient of variation (or variability) as a measure of relative variability. While the coefficient (abbreviated to CV) is usually defined by the equation $CV = 100/AM$ (which is the form to which these notes refer), the more general definition is of a specified measure of dispersion expressed as a percentage of some appropriate measure of central location. Simpson and Rowe[1] give a list of seven formulæ which by no means exhausts the logical possibilities

In view of certain erroneous statements which have been made as to the nature and meaning of this coefficient, and of certain fallacious inferences drawn from its use, it is thought desirable to offer the following comments, based upon a preliminary examination of the problem from the biological point of view, in the hope that workers with the necessary statistical and mathematical equipment might be persuaded to give some attention to the development of this device which, it is thought, could be of considerable value in taxonomic practice

The following points in connexion with this coefficient seem to have been overlooked

(1) It is an index expressing one mean value (root mean square deviation) as a percentage of another mean value Accordingly, the values normally calculated may be regarded as being possibly not true values since no correction is ever made for correlation effects, and notably no correction is made for the effect of spurious correlation which arises where an index is calculated from mean values, as shown by Pearson[2], nor is correction ever made for the correlation which generally exists between a mean and its standard deviation

(2) The numerator of the index is a quantity determined by many factors according to which it can be partitioned The *CV* is customarily calculated only from such values of the standard deviation as may be to hand: at best these are sample values and it cannot be held that they accurately represent the variability of the particular group to which they refer Accordingly, it is likely to be erroneous to compare the *CV*'s of two groups, unless the conditions of sampling, that is to say, the sources of variance, are identical Even when sampling conditions are similar, such comparison of *CV*'s can be regarded as evidence of relative variability of the groups only in respect of the particular measurements to which they refer. Comparison on other measurements may reverse the relative positions.

(3) The correlation between a mean (of a particular measurement) and its variance is extremely variable and is itself a feature to be determined. Accordingly, values of the *CV* cannot usually be predicted on biometrical grounds alone Thus, for the one measurement in a particular species the *CV* may or may not vary with sex, age, locality, season or other factor Again, the coefficients of different measurements in the one species may or may not be the same and may or may not behave similarly in respect of such factors as sex, age and so on Similar observations may be made in respect of the *CV* of a particular measurement made on different species, or genera I have compiled tables of means, standard deviations and *CV*'s, and find it generally demonstrable that the characteristic value of the *CV* for any measurement in any group cannot be predicted, but must be separately determined. This does not deny that the behaviour of this coefficient might be according to some discernible law, particularly if some alteration were made in the manner of its calculation. However, this is a question of the relationship between two variables (the mean and the variance) under various conditions, and such relationship cannot be analysed by means of an index. Finally, as a matter of immediate practical importance, it is fallacious to attempt to set any *general* limits to the value of the *CV* or to draw any particular conclusions from departures from such limits

(4) Since so many factors may contribute to the size of the variance, and since the manner of that contribution cannot be predicted, it is impossible to argue *to the sample* from the value of the *CV*. But departures in subsequent samples, from the value of the *CV* established for a particular specification of sampling, might serve to indicate that the conditions of sampling had been departed from, or that certain changes in the population had occurred.

However, despite these limitations to the *CV* it is desirable to have some measure of relative variability, and it is thought that with some modification, and with care in the specification of the conditions of use, the *CV* can serve this purpose. In the first place a *CV* should be cited, as a taxonomic feature, only where the material from which it was obtained can be precisely specified. Secondly, since the object is to permit comparisons, it would be desirable to effect some choice of conditions of sampling which can be generally reproduced, thus it might be wise to specify the *CV* for the sexes separately, to specify a single locality (say, the type locality) and only a few age groups Thirdly, it would be a useful innovation to cite the *CV* partitioned according to the various sources of variance; coefficients could be quoted for each of the most important sources of variance and one for the residual variance. The latter might prove to be a fundamental characteristic of the species. The need for coefficients for 'interaction' would depend upon the magnitude of the effect. Finally, further refinements could be introduced by the adjustments possible through the covariance analysis. However, the *CV* should be an end-product of a detailed analysis. crude values should not anticipate such analysis.

While the *CV* in its present form is of very limited value it probably could be made a most useful adjunct to the usual set of statistical measures quoted in taxonomic works.

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[1] Simpson and Rowe, "Quantitative Zoology" (McGraw-Hill, 1937)
[2] Pearson, K, *Proc Mag Soc.*, **60**, 489 (1897).

A General Class of Confidence Interval

AMONG types of statistical inference about unknown parameters statements are possible which have a statistical truth, that is, they are random variables such that within the statistical framework adopted the probability of their being in error is known In these statements intervals, called by Neyman confidence intervals, are assigned to the value of an unknown parameter. On generalization to more than one unknown parameter these intervals become multidimensional regions, but I have pointed out[1] that the existence of such regions does not of itself imply in Neyman's theory the corresponding existence of regions of lower order, equivalent to the elimination of irrelevant unknown parameters

However, the logical statement concerning the simultaneous boundary of several parameters *includes* a statement about the *maximum* boundary of any selected set of these parameters, and consequently if the total statement is true with probability $1 - \varepsilon$, the included statement is true with probability not less than $1 - \varepsilon$ When the selected set consists of only one parameter, this fact gives rise to a general class of confidence interval for one parameter that includes all previously known 'exact solutions' with probability $1 - \varepsilon$ and also new solutions with probability not less than $1 - \varepsilon$ When optimum exact solutions do not exist, investigation of the optimum solution of the new type may still be possible.

In Fisher's most recent discussion[2] of his theory of fiducial probability, including the problem of testing the difference between two means, for which the Behrens–Fisher test does not constitute a solution *in the above sense*, he seems to throw out a challenge to critics of this test to provide an alternative 'tolerable solution'. In my original critical discussion[3] the existence was noted of a two-parameter fiducial distribution for the true difference between the two means and the true ratio of variances. In addition to solutions of the confidence interval type previously noted, this two-parameter distribution implies a possible solution of the new type suggested above, for which the optimum (that is, shortest) confidence interval may be calculated This particular solution, since it is based on an inequality, is not obviously more powerful than others based on exact solutions of a non-optimum type, but its statistical properties are open to investigation But 'validity' and 'tolerability' should not be confused—the solution proposed here is valid in the sense defined, whether or not on more detailed examination it proves 'tolerable'

Note added September 23 Since this letter was written, Dr. B L Welch has shown me the manuscript of a forthcoming paper in *Biometrika*, in which he puts forward a new solution of the confidence interval type for the 'difference between two means' problem His solution appears to be exact, at least in the sense of allowing a series expansion for the true limits in terms of the initial large-sample normal approximation, and promises, much more than my own suggestion, to provide the so far missing 'tolerable' solution I have also been interested to learn from recent conversation with Prof A Wald of some related unpublished work of his on the existence of such an exact solution

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Random Associations on a Lattice

GIVEN a lattice of $m \times n$ points, suppose that each may be 'black' or 'white' with probabilities p and $q = 1 - p$. The probability distribution of the number of 'black-white' joins is then of interest in several branches of science[1,2,3] The expected number is $2pq(2mn-m-n)$ and the second moment about the mean is $2pq\ (8mn-7m-7n+4)\ +\ 4p^2q^2\ (13m+13n-14mn-8)$

As m and n increase, the distribution tends to normality, and this may be proved by methods similar to those used by Bernstein[4] in his work on Markov chains. Similar results can be obtained for the number of 'black-black' joins and also the corresponding results in three dimensions. Levene[5] has announced results dealing with a different but similar problem. A full account will appear later

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[1] Mood, A. M, *Ann. Math Stat.*, **11**, 367 (1940)
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Experiment and Theory in Statistics

MR D. V. LINDLEY[1] distinguishes between the curve of best fit and the regression curve on the ground that the former gives the best estimate of the relation between the true values of the variables, while the latter gives the best estimate of the true value of one variable from the observed value of the other He thus provides a convenient opportunity to raise a question that I have long wanted to raise, namely, whether there is any experimental evidence for this and similar deductions from statistical theory.

Direct experimental tests are not easily devised, for the meaning of the conceptions involved in such statements is derived largely from the theory on which they are based But the first statement seems capable of test The true values must surely be independent of the method of examining them. Accordingly, if many different sets of observations are made on a system by many different ways, the curves of best fit from the different sets, rightly calculated, should agree significantly better than curves calculated in any other way, for example, better than the regression curves. Is this true?

Nor are the tests easy to apply. A single worker seldom accumulates enough observational material to apply the test he cannot use the observations of others, because sufficient details are scarcely ever published. The application of the tests requires organised co-operation. Until it is undertaken and the tests proved to be successful, all use of elaborate statistical theory is precarious.

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Sept. 2

[1] *Nature*, **158**, 273 (1946).

DEVELOPMENT OF MILK RECORDING IN GREAT BRITAIN

IT has become clear in recent years that the general performance of British dairy stock in terms of milk yield and breeding efficiency is sufficiently low to constitute a major handicap to any advance, although the existence of some high-producing cows and high-yielding herds shows what might be accomplished by improved breeding and husbandry.

The obvious technique for assessing levels of performance is milk and butter-fat recording. But to attain real value, recording must be applied to a sufficiently large sample of the cow population to give a representative picture of the industry, and its results must be not only comprehensible to cattle breeders but also legitimately usable in any improvement programme. Those considerations formed the background to the discussions on the collection, interpretation, and use of milk performance records by the British Society of Animal Production at its Glasgow meeting held on August 7

The milk recording movement in Great Britain is not a new one. Measures of co-ordination have existed for some time; for example, the Scottish Milk Records Association was formed in 1914. However, an almost negligible amount of scientific study has been given to it, its main uses being to furnish records for the information and propaganda of the individual breeder and for breed societies to incorporate in some form of register of superior animals. The movement as such attained a greater measure of co-ordination in 1943, when the Milk Marketing Board assumed responsibility for recording in England and Wales, but differences in the technique of recording and presentation of records still occur between the English and the Scottish systems. In 1943 about 5 per cent of the cow population of England and Wales were recorded; by 1946 the recorded sample of 17,000 herds included about 17 per cent of the cow population. Mr. Joseph Edwards estimates that, under the present system, a total of twenty to twenty-five thousand herds would give a sample of 20 per cent of the cows. This would be sufficient for the investigational purposes now envisaged by the Board, relating to the yields of milk and butter-fat by breeds, as between pedigreed and non-pedigreed stocks, and according to age and other environmental conditions, such as season of calving and frequency and methods of milking, as well as to keep track of the results of artificial insemination as a means of livestock improvement. Mr. Edwards' description of the methods to be used by the Bureau of Records of the Board in collecting, tabulating and presenting the data was fully appreciated, especially by those members of the Society who recognize that, as Dr. H. P. Donald expressed it, "one of the proper studies of recording is recording itself".

The stage is now being set for the beginning of a new era of development in milk recording, so far as Great Britain is concerned. There has been much confusion of thought as to the uses and limitations of recording systems and the records which emerge from them. The problems fall into two broad groups: (*a*) those of the techniques and systems themselves: their accuracy; the analysis of results in order to give data which can be utilized for comparative evaluations of performance; the standards and training of the personnel; the degree of intimate co-operation with the farmers that can be brought about; (*b*) those of the purposes of the records: to guide breeding policies; to enhance production by non-genetic means, such as improved feeding and husbandry; to be combined with health surveys to assess the incidence and relative significance of the various sources of loss, wastage, and inefficiency which affect the industry, and so to provide a factual background for specific investigations.

Extension of recording in combination with field survey work on such lines is being actively pursued in New Zealand, and Mr. Arthur Ward's account of recent developments there gave a definite picture of a satisfactory working mechanism, some of the attributes of which might well be imitated in Great Britain. Because of the benefit accruing from proper collection of data to the New Zealand dairy industry as a whole and to the research institutions, the Government and the industry contribute to the funds of the movement, while representatives of the industry and of the Government form a technical committee which decides the data to be collected and the problems to be investigated. But the crucial steps in the conduct of the work are those which ensure that the farmers are kept fully informed of the reasons for the particular investigations, as well as of the results which emerge from them.

In connexion with the new developments in Great Britain, it is important to recognize that the interpretation and application of the performance data in such an industry must be carried out on more than one plane. The individual herd is a relatively small unit; the breed amounts to a more or less discrete, much larger group. The individual breeders have their own domestic herd problems; people concerned with the larger groups are dealing with cattle aggregates, that is, with populations. (The growing use of artificial insemination introduces an intermediate set of problems.) The requirements and purposes of the two interests are not always easily reconciled, and differences in point of view may be magnified when the whole cattle population of a country is involved.

The individual herd owner knows the history of his herd, of changes in management, and of disease effects. This knowledge, if intelligently used, can give a good background to a practical assessment of performance records. But these records must be reasonably presented, and in such a form that the owner of the herd can trace the performance also of the bulls in use, as, for example, by dam-daughter comparisons. For this purpose the graphical presentation of raw records is straightforward and practical. 'Corrected' records applied to individual cows can be misleading or misread, and are certainly disliked.

On the other hand, those who are concerned with the broader aspects—the population basis—require the data in forms which allow adequate comparison; for this, some series of correction factors are necessary. Though corrections for regional differences would be seriously unpopular in many quarters, the fact that they can be derived, as, for example, in the work of Prof. Bonsma in South Africa, or for Swiss alpine conditions, points to possibilities even in Britain. Meanwhile, it is a sad reflexion that in their new advanced registry scheme, the Ayrshire Cattle Society has perforce to use correction factors derived in America for American conditions, and that Sanders' factors, developed some twenty years ago for a limited material in England, are of doubtful validity for other British recording data. The mass of records which will now be automatically collected and tabulated under the Milk Marketing Board scheme will give badly needed material for bringing our knowledge of the dairying industry in Britain at least into line with that of other countries. Mr. Edwards' assurance that this material will be available to breeders and to research workers is particularly welcome, and goes far to ensure wide confidence in the scheme and in the data.

For confidence in such data—in all stages of their collection, tabulation and treatment—is vitally important. That there must be some arbitrary decisions, or compromises, in the records themselves is always admitted (a standard lactation of 305 days is one such compromise); so also is the fallibility of an official record as representing the true performance in any one lactation of any one cow. But the validity of the records is of interest to more than the individual herd owner; within breeds, between breeds, within and between localities and farming systems, within and between countries, breeders, administrators and research workers must have equal confidence in the validity of the records before proper, intelligent and progressive use can be made of them. To this end, the fundamental needs are for well-trained personnel throughout the recording system, for high standards of accuracy within practical limits, for a wide adoption of general principles and methods, and for close collaboration between breeder, recorder and investigator.

The records when collected must be usable and used; continuous, independent, scientific study and advice must be freely available and accepted, so that the recording movement may function soundly and progress to greater service to the milk-producing industry.

J. E. Nichols

MANTLE CHAMBERS OF *TRIDACNA ELONGATA*

By Prof. K. MANSOUR

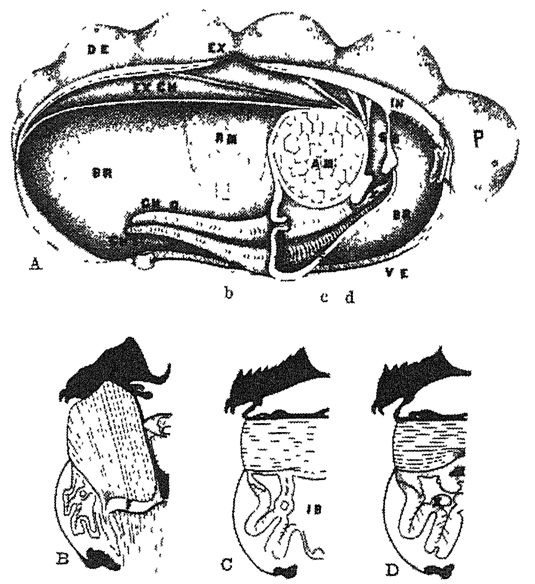
Department of Zoology, Fouad I University, Cairo

In a preliminary communication[1] it was pointed out that members of the Tridacnidæ are of a comparatively high efficiency in taking in ordinary net-zooplankton. This efficiency was attributed to the possession of members of this family of a well-developed sucking, sieving and pumping mechanism which is constituted by the different chambers of the mantle.

Both Vaillant[2] and Lacaze-Duthiers[3] devoted some attention to the morphology of the mantle chambers of *Tridacna elongata*, but neither of them realized the significance of the form and the arrangement of these chambers.

Fig. *A* represents a dissection of the right half of *Tridacna elongata* displaying the mantle cavities and how they are related to one another. From the inhalant opening (*IN*) water passes into the branchial chamber (*BR*), in which the gills hang freely. This cavity is at its narrowest in the region of the muscles (*AD* and *RM*). On percolation through the gills, the water passes into the interlamellar chambers (*CH* 0 and *CH* 1) of the outer and inner demibranchs respectively.

Just behind the foot and below the adductor muscle, the inner lamellæ of the inner demibranchs



Mantle chambers of *Tridacna*

A, right half of the animal with the different chambers exposed *B*, *C*, *D*, transverse sections across *b*, *c*, *d* of *A*.

fuse with one another, forming a well-developed septum (*S*) which is referred to as the interbranchial septum. This septum defines a chamber—the interbranchial chamber (Figs. *B*, *C*), which is bound dorsally by the investment of the ventral surface of the adductor muscle, laterally by the axes of the gills and ventrally by the interbranchial septum itself. This chamber is at its deepest anteriorly, where the interbranchial septum is almost vertical in position and is as high as the foot. This vertical anterior wall of the chamber is very remarkable in having a central well-defined opening, which puts this chamber in direct communication with the branchial chamber. This opening was referred to by Vaillant[2], who concluded, from its form and the orientation of its lips, that it can only lead the water directly inwards from the branchial chamber. Fuller description of this opening and the part it plays in the life of the animal will be referred to elsewhere. At present it suffices to mention that this peculiar opening is established at an advanced stage in the life of the animal, since in specimens up to 5 cm. in length there is no trace of it, while specimens of 10 cm. all showed it in a very distinct fashion.

Anteriorly, the interbranchial chamber communicates on each side with the interlamellar cavity of the corresponding inner demibranch and laterally it receives the water percolating through the remaining part of the same demibranch. Posteriorly, this chamber narrows to a tube, which curves vertically upwards and puts this interbranchial chamber in communication with the exhalant chamber (*EX*, *CH*), which lies dorsally between the forwardly extended mantle edges (*DE*).

The interlamellar cavities of the outer demibranchs (*CH* 0) are quite independent of the interbranchial chamber. They open posteriorly at the basal portion of the vertical tube referred to above, which communicates between the epibranchial chamber and the exhalant chamber.

This vertical passage is bound anteriorly by the investment of the posterior surface of the adductor muscle and posteriorly by a septum (*SS*), which is continuous with the interbranchial septum and which separates the inhalant part of the branchial chamber from the exhalant one. This septum corresponds to the intersiphonal septum of other Lamellibranchiata. This vertical channel in its upper region passes insensibly into the exhalant chamber. On the other hand, its lower or basal portion has a number of ridges and protuberances which form a composite plug, which on contraction of the animal closes off this channel and consequently the exhalant chamber from the interbranchial chamber and the interlamellar cavities of the gills.

The composite plug referred to above is partly formed of a fairly big protuberance on the lower posterior region of the investment of the adductor muscle (Figs. *A* and *D*). This protuberance marks the spot where the axes of the gills become free from the body wall of the animal As these get loose from the investment of the adductor muscle their edges are thickened and are directed first forwards and outwards and then backwards and inwards (Fig. *A*, *X*), where they end at the base of the intersiphonal septum (*SS*). In this fashion the free edge of each axis takes the form of a well-developed notch with greatly thickened lips which mark the opening communicating the interbranchial cavity with the vertical tube and consequently the exhalant chamber. At the base of the siphonal septum (*SS*) there is a thickened part which corresponds to the protuberance facing it on the investment of the adductor muscle.

When the animal contracts, the posterior region of the thickened mantle edge, which is very highly muscular (*A*, *P*), coils downwards and forwards and comes to press on the siphonal septum, which in its turn presses on the posterior surface of the adductor muscle. In this fashion the thickened region of the septum, together with the protuberance of the investment of the adductor muscle, are applied close to one another, blocking the major part of the cavity of the tube. At the same time, the thickened edges of the free part of the axes are also applied together, blocking the side parts of this communicating tube.

The exhalant chamber, which is continuous posteriorly with the vertical tube, is in the form of a well-defined bag extending on the dorsal surface of the animal. It ends blindly at the extreme anterior end of the animal (*A*). It opens to the outside by the well-defined exhalant opening (*EX*), and its only communication with the other chambers of the mantle is through the communicating vertical channel (cf. text Fig. 3 of Yonge[4]).

The exhalant chamber is provided with a number of well-defined muscle bands (oblique and vertical), running between the floor of the chamber in the region of the adductor muscle and the roof of the chamber in front and behind the exhalant opening. The part these muscles play in the process of pumping out the water from this chamber to the outside is very obvious. The retractor muscles of the foot also seem to have a very important part in this process. A great number of their elements run between the foot (*F*) and the thickened mantle edge in the region of the exhalant opening (*B*).

The combined action of the muscles of the thickened mantle edge especially at the posterior end, of the adductor muscle, of the vertical and oblique muscles of the exhalant chamber and partly that of the retractor muscles, brings great pressure upon the contents of the exhalant chamber, and hence the remarkable spouting of the water through the exhalant opening. The insertion of the retractor muscle into the mantle edge in the region of the exhalant chamber seems also to provide support to the roof of the chamber round the opening and prevents rupture through the great pressure from the inside when contraction takes place In the contracted condition the composite plug referred to above seems to be quite efficient in stopping any communication between the exhalant chamber and the interbranchial and the interlamellar portions of the mantle cavity. The difference of pressure in these two sets of chambers when the animal is contracting must be very great, and the importance of the plug in such a condition is quite obvious.

When the animal retracts, the capacity of the exhalant chamber increases greatly, the vertical tube increases in width, and water coming originally from the branchial chamber is sucked upwards into the exhalant chamber from the interbranchial chamber and the interlamellar cavities of the gills.

The alternate contraction and retraction of the muscles of the animal in the way described above causes, at least at intervals, a strong current of water to pass through the gills. The food-collecting value of this process cannot be overlooked. Experimental data pertaining to the pressure in the different chambers and the rate of flow of the water through the animal are forthcoming.

[1] Mansour, K , *Proc. Egyptian Acad Sci.*, **1** (1946) (in the press)
[2] Vaillant, L , *Ann Sci. nat Zool* , (5), **4** (1865)
[3] Lacaze-Duthiers, H. de, *Arch Zool. Exp. Gén* , (3), **10** (1902).
[4] Yonge, C. M., Great Barrier Reef Expedition Sci. Rep., **1**, No. 11 (1936).

PERIODIC PARTIAL FAILURES OF AMERICAN COTTONS IN THE PUNJAB

A COMPREHENSIVE account of this malady, together with the remedial measures to be adopted, has been given by Prof. R. H. Dastur ("The Periodic Partial Failures of American Cottons in the Punjab : Their Causes and Remedies". Sci. Monograph No. 2, India Central Cotton Committee, Bombay, 1945). The failure in question is of the nature of a physiological disease, popularly known as 'tirak', the symptoms of which include the premature cracking of bolls with immature seeds and poor quality of lint. On light sandy loams the leaves become discoloured at the onset of the reproductive phase, the characteristic yellow and red colours being followed by premature leaf fall. A study of the cotton crop in the Punjab in all its phases of growth led to the general view that where tirak is evident the vegetative and reproductive phases are physiologically unbalanced : the detailed investigation of this hypothesis has been productive of many interesting results of both practical and scientific interest.

In the first place, tirak is now regarded as a comprehensive term for several abnormal physiological developments induced in American cottons (*Gossypium hirsutum*) under quite different soil conditions.

Two particular soil types are specified as being liable under certain conditions to give rise to tirak: these are light sandy loams deficient in nitrogen, and soils which contain free sodium salts or sodium clay in the subsoil. Different types of physiological disorder are induced under the two sets of conditions, but the name tirak is still retained to cover both. The more evident symptoms which develop on the first soil type have already been indicated; but in addition it has been found that in the leaves of affected plants there is an abnormal accumulation of starch in the cells of the mesophyll. This starch is not removed during the night, as in normal leaves, but continues to accumulate until in extreme cases the chloroplasts become ruptured. An abnormal accumulation of a tannin-like substance is also present in the cells, its presence being antecedent to the development of the external symptoms of tirak. The relation of these abnormal developments to nitrogen deficiency has been established by appropriate experimentation. The observation that, on light sandy loams, tirak cannot be attributed to nitrogen deficiency alone led to investigations of the water economy of the plant. Water deficiency during the reproductive phase was also found to be a factor in the situation. Thus where water deficiency is important, as in soils with subsoil salinity, affected plants show a pronounced drooping of the leaves; these leaves also become dark-coloured and dull, they lose their fresh green shining appearance and are prematurely shed. In this type of tirak the yellowing seen in nitrogen-deficient plants is not present; there is likewise no evidence of the accumulation of starch or tannin, but certain protoplasmic abnormalities are evident. Both types of tirak-affected plants are characterized by a low potassium content in leaves and carpels, depressed synthesis of proteins, and decreased oil formation in seeds.

A careful consideration of all the relevant biochemical data has led to the conclusion that the low potassium content is the starting-point of the internal disorders in tirak plants. The disorders associated with this deficiency develop in different ways in plants growing on the two soil types: in the light sandy loams the uptake of potassium is low because of the shortage of nitrogen; on saline soils physiological drought interferes with the normal uptake of minerals. Thus Prof. Dastur concludes (p. 71): "The common symptom, *viz.*, immaturity of seed, therefore, developed in plants on both soil types though the symptoms exhibited by the leaves of *tirak*-affected plants on the two soil types were found to differ". Such a finding gives some idea of the difficulties inherent in the investigation of a crop failure which is due to physiological disorders.

Broadly speaking, the field aspect of the problem has been diagnosed along the following lines. When Punjab-American cottons are sown early in May, the combination of light soil, long days and regular water supply makes for strong vegetative growth. Flowering begins about the last week in August. It is a curious and important fact that any change in the date of sowing is not accompanied by a similar shift in the onset of flowering; that is, all sowings tend to come into bearing within a rather narrow period. Moreover, flowering tends to occur in a flush and thus imposes a heavy demand on the supplies of nitrogen and other minerals. This is particularly so in the case of the strongly vegetative plants which result from the early May sowings. In point of fact, a large number of flowers do not come into fruition as fully developed bolls. This tends to be accentuated in soils which are deficient in nitrogen or which suffer from physiological drought, with the concomitant development of the two types of failure described as tirak. These and many other interesting aspects of the problem are fully described and discussed.

A substantial part of the report deals with the remedial measures to be adapted to different soil types. To quote from the report (p. 137): "The application of nitrogen to light sandy soils prevented the development of *tirak* symptoms caused by nitrogen starvation and the application of extra water at the fruiting stage prevented the development of physiological drought on soils with saline subsoils Both these remedies proved specific for the two soil types and naturally they must be applied at the right place.

"The importance of the June-sowings as a preventive measure against *tirak* was its general applicability. It was found efficacious on all soil types as it put the crop in equilibrium with its surroundings. . . . The plants were able to carry on their normal functions with less nitrogen and less water [than the May-sowings] and the deficiency of these substances did not develop. The plants were also better able to stand the adverse weather conditions at the fruiting stage and thus general intensification and spread of *tirak* were greatly lessened. The internal economy of the plant greatly improved and the plant produced less of sticks and more of fruits. . . . This simple measure of deferring sowings by about three to four weeks has been found to result in great profits to cotton growers and many of them have already benefited."

Prof. Dastur and his collaborators, and the Indian Central Cotton Committee which sponsored and financed the work, are to be congratulated on the successful outcome of this long and intricate investigation.

TRANSMISSION OF FINGER-PRINTS BY RADIO

THE transmission of pictures and of written or printed material over line and radio telegraphic circuits is an achievement of long standing; but in recent years enormous advances have been made in the technique of radio transmission and reception in this field, resulting in very marked improvement in the quality and detail of the reproduced pictures, excellent examples of which are frequently to be seen in the daily Press. The successful transmission to a distance of reproductions of human finger-prints obviously demands an unusually high quality in this technique, and a study of the problems involved in this application has been the object of tests conducted during the past year between Great Britain and Australia.

These tests are described in an interesting pamphlet entitled "Radio Transmission of Finger Prints", by Superintendent F. R. Cherrill, officer-in-charge of the Finger Print Branch, New Scotland Yard*. A foreword to this document refers to an article entitled "The Description and Use of the Pores in the Skin of the Hands and Feet", published in the *Philosophical Transactions of the Royal Society* in 1684 by Dr. Nehemiah Grew, who was at one time secretary

* Radio Transmission of Finger Prints. By Supt F. R. Cherrill. Pp. 12 (Commissioner of Police of the Metropolis, New Scotland Yard, London, S.W.1, 1946.)

of the Society. A drawing of a hand emphasizing the features of finger- and palm-print patterns is reproduced from this article. The memorandum is, however, essentially concerned with the results of successful tests in the long-distance identification of criminals conducted during the past year by New Scotland Yard in co-operation with the Commissioner of Police, Victoria, Australia, and Messrs. Cable and Wireless, Ltd.

The report is illustrated by a specimen transmission card which contains, in addition to two photographs of the wanted person, an enlarged print of one finger with coded description of the other nine digits, and a complete description of the individual, and the information required in connexion with him. All this matter is contained on a card approximately 10 in. × 9 in. in size; and this formed the picture which in one test was transmitted from London to Melbourne in seven minutes so successfully that a cable setting forth the person's record was received from Melbourne the next morning. These tests thus culminated in the successful identification in Australia of a person who was actually in custody in Great Britain and whose trial was imminent. Similar facilities for radio picture transmission are now available between London and many towns in various parts of the world, both within and outside the British Empire.

BIRDS OF PALESTINE

WHILE serving in Palestine, Captain Eric Hardy became the secretary of the Jerusalem Naturalists Club which had been founded for the troops by Middle East Command to stimulate interest in and co-ordinate the numerous inquiries in natural history that were already being pursued by a number of individual soldiers. One of the most notable activities of the Club was the listing of the birds of Palestine. The duty was undertaken because of the lack of a modern and authoritative account of Palestinian birds, and, besides their records of 364 species and 68 sub-species, work was also carried out on problems of migration. These, together with records of the most-used bird haunts, have been put together by Captain Hardy in a privately printed list which, it is hoped, will be the forerunner of an authoritative and comprehensive handbook of Palestinian ornithology*.

The region is of particular interest because the Palæarctic region of the north and the Ethiopian region of the south meet across the centre of the country. The little owl, for example, shows interesting northern, southern and intermediate races, and several African birds like the sunbird (*Cinuyris*), the darter (*Anhinga*), the sooty falcon and the lappet-faced vulture (*Otogyps*) penetrate the country from the Syro-African Rift Valley, and oriental birds like the fishing owl (*Ketupa*) and the black-headed bunting (*Emberiza melanocephala*) also occur. The main migration routes between Europe and Africa pass through the country.

The only native bird to migrate to Palestine is the gannet (*Sula bassana*), although several 'British' species from eastern Europe, like the European swallow, the rook, redshank, teal and cuckoo, are seen. There are also several closely allied races of the birds known in Britain, like the chaffinch, great tit, kingfisher, robin, song thrush and blackbird. The blackbird, skylark and song thrush do not sing in Palestine in their winter sojourn, and the robin sings only occasionally at daybreak. The cuckoo rarely calls on its migration; nightjars do not sing. Absence of bird song, particularly thrush song, is noticeable to the British visitor, but the song-birds common to Britain and Palestine are the greenfinch, great tit, chaffinch, goldfinch, corn-bunting and, occasionally, the chiff-chaff. The familiar calls of the robin and redshank are commonly heard in winter, but the robin, as well as the blackbird and song thrush, are much shier and less easy to approach than in Britain. Birds peculiar to Palestine include the Palestine babbler, the Palestine blackstart, the Palestine graceful warbler, Tristram's grackle and the Palestine sunbird. The grackle and the sunbird are extending their way northwards from the Dead Sea depression. The bulbul is supposed to have increased its numbers considerably this century, but several birds have decreased. The white stork, the lammergeir, the imperial eagle and the white-faced duck no longer nest in the country, while the great bustard, the Syrian ostrich and the Egyptian goose are apparently extinct in Palestine. Unlike Cairo, Jerusalem and the cities of Palestine are not the habitat of flocks of kites, but also unlike Cairo, Jerusalem, Haifa and Tel Aviv have a large summer nesting population of swifts.

* A Handbook of the Birds of Palestine. By Captain Eric Hardy Pp iii+50. (Education Officer-in-Chief, G H.Q., Middle East Forces, 1946.)

CARNEGIE INSTITUTION OF WASHINGTON

REPORT FOR 1944-45

ONE of the most interesting passages in the report of the president of the Carnegie Institution of Washington, Dr. Vannevar Bush, which is included, together with the reports of the executive committee, the auditors, and on departmental activities, in the Yearbook No. 44 for 1944–45, covering the year July 1, 1944–June 30, 1945, is that in which he discusses the future of scientific research, and particularly the bearing on it of the Selective Service, the further extension of which as regards science and engineering students has since been severely criticized by H. A. Meyerhoff (*Science*, April 19). Dr. Bush points out first that while the United States is at last awake to the value of scientific research, it is not by any means certain that every area where the scientific method can add to man's understanding of himself and his environment will be adequately explored, and that the danger of lack of balance between applied research, research in the physical sciences, medical science and in other fields may be exaggerated by the serious deficit in scientific man-power due to the policies pursued during the War. The two governing principles, that every citizen should be ready to sacrifice equally in the common cause and that every man should be used in the place where his talents can contribute most fully to the common effort, were not in balance. As a result, by taking too many trained young scientific workers and engineers out of the laboratories and industry, part of the war effort was nearly wrecked, while at the same time the future was sacrificed to immediate needs and a lack of scientific man-power created from which the country will not recover for many years.

Dr. Bush believes that the lack of a sufficient number of brilliant young men with a basic training in fundamental science will be particularly unfortunate and will severely handicap the Carnegie Institution in the immediate post-war years. While, however, we have had a partial moratorium on the creations of fundamental science, and have caused a deficit of scientific man-power, we have undoubtedly a new stock of dammed-up ideas. This factor, together with the probability of adequate support for scientific effort, makes the vista in science attractive if we can assume a peaceful world. To ensure that the present emphasis on science does not result in unbalance and a neglect of other fields of effort, it is essential to educate fully all the young and brilliant minds that can be found and to present clearly the various callings as young men start their careers, so that none requiring recruits is overlooked, not forgetting that political careers must be made attractive for sound thinkers if democracy is to function effectively in a world of growing complexity.

The Institution, the president reports, has emerged from the War in sound financial condition, with increased endowment, although the rate of income from endowment has dropped severely. It has conducted much war research under contract for the Government, contributing its facilities, its normal overhead and the services of its regular staff, and being reimbursed only for additional staff, equipment and overhead. The salary scale of the Institution requires revision, and a new retirement and insurance plan has been put into operation.

As regards the research activities of the departments and divisions during the year, there is in general little to add to the broad picture given in the previous Yearbook (see *Nature*, 156, 453; 1945). Reference may, however, be made to plans of the Department of Terrestrial Magnetism for the investigation of phenomena of thunderstorms and its investigations of the rate of ionization inside a room. Some results of the attempt of the Division of Zoology of the United States Public Health Service to correlate by radioactive-tracer techniques the localization of heavy metals in the body and their chemotherapeutic activity are reported, as well as ionospheric data obtained at Watheroo and Huancayo Magnetic Observatories. The Division of Plant Biology has found that the antibiotic properties of the material isolated from cultures of the green alga *Chlorella* are due to, or associated with, the presence of unsaturated fatty acids, but the activity only develops on exposure to air and light. Pure unsaturated fatty acids showed the same behaviour, including linoleic, elaidic, β-eleostearic and β-licanic acids. In the Department of Embryology much time has been devoted to the perfection of a new technique of microtomy intended to reduce the distortion of tissues caused by the pressure of the microtome knife, and the position of embryology as a co-operative science is discussed in the report in relation to future work of the Department.

In the Department of Genetics cytogenetic studies reported include the induction of mutations in the short arm of chromosome 9 in maize and preliminary studies of the chromosomes of the fungus *Neurospora crassa*. An extensive investigation of the genetics of acquired bacterial resistance to drugs and other antibacterial agents has been initiated, including work on resistance to penicillin, sulphonamides, inorganic salts, bacteriophages and ultra-violet radiation. Other work has been directed to the development of high-yielding strains of *Penicillium* by submerged culture and of an aerosol method for the chemical treatment of *Drosophila melanogaster*, and work on the cytogenetics of *Drosophila* and the genetic structure of natural populations is also reviewed. The report of the Nutrition Laboratory includes a brief review of the contributions of the Laboratory during the last thirty-eight years, emphasizing the work on the development and testing of apparatus for the measurement of heat production and elimination, respiratory exchange and surface and internal body temperature.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Tuesday, October 15

British Ecological Society (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 2 15 p m —Discussion on "Survival and Extinction of Flora and Fauna in Glacial and Post-Glacial Times" (to be opened by Dr Jessen)

British Society for International Bibliography (at the Institution of Electrical Engineers, Savoy Place Victoria Embankment, London, W.C 2), at 2 30 p m —Dr B M Crowther "The Use of the Universal Decimal Classification in Periodical Abstracting Services for Scientists and Engineers", Dr S C Bradford "The Problem of Complete Documentation in Science and Technology".

London School of Economics and Political Science (at Houghton Street, Aldwych, London, W C 2), at 4 45 p.m —Sir Theodore Gregory "The Outlook for India"* (To be repeated on October 21 and 22)

Wednesday, October 16

Institute of Fuel. Yorkshire Section (at the University, Leeds), at 2 30 p m —Dr A L. Roberts "Radiant Heating—its Principles and some Applications"

Society of Chemical Industry, Agriculture Group (in the Physical Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S W 7), at 2 30 p.m.—Dr F. Gross: "An Experiment in Farming the Sea"*.

Royal Microscopical Society (in the Hastings Hall, B M A. House, Tavistock Square, London, W C 1), at 5 p m —Mr E Wilfred Taylor "Improved Image Illumination and Contrast with the Metallurgical Microscope".

Institution of Electrical Engineers, Transmission Section (at Savoy Place, Victoria Embankment, London, W C.2), at 5.30 p m. —Mr. J. Andrew Lee. Inaugural Address as Chairman.

Institute of Petroleum (at 26 Portland Place, London, W 1), at 5 30 p m —Mr. A. T Wilford. "The Lubrication of Pre-Selective Gearboxes".

Royal Institute of Chemistry, London and S E Counties Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C.1), at 6.30 p m —Discussion on "The Publicity of Science by Radio" (to be opened by Dr W E. van Heyningen)

Royal Institute of Chemistry, Newcastle-upon-Tyne and North-East Coast Section (joint meeting with the Society of Chemical Industry, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6 30 p m —Lieut -Colonel A Wedgwood · "Problems in the Concentration of various Small Sized Minerals".

British Association of Chemists, London Section (at Gas Industry House, 1 Grosvenor Place, London, S W 1), at 7 p m —Mr. J H F. Smith· "Fire and Explosion: 1. Inflammable Concentrations and Ignition Temperatures".

Thursday, October 17

Chemical Society (joint meetings with the South Yorkshire Section of the Royal Institute of Chemistry, the Sheffield Metallurgical Association, and the Sheffield University Chemical Society, in the General Lecture Theatre, The University, Western Bank, Sheffield), at 2 30 p m. and 6 p m —Prof Jaroslav Heyrovsky "The Principles and Applications of Polarography".

Institute of Fuel, East Midland Section (at the Gas Demonstration Theatre, Nottingham), at 3 p m —Babcock and Wilcox Film 'Steam" (presented by Mr. E L Luly).

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m — Major P. L. Teed "Anglo-American Magnesium Production"; Dr. Anthony Caplan and Mr J K Lindsay · "An Experimental Investigation of the Effects of High Temperatures on the Efficiency of Workers in Deep Mines"

Institution of Electrical Engineers, Installations Section (at Savoy Place, Victoria Embankment, London, W C.2), at 5 30 p.m. —Mr J F Shipley. Inaugural address as Chairman

Society of Chemical Industry, Road and Building Materials Group (joint meeting with the Rheologists' Club, at Gas Industry House, 1 Grosvenor Place, London, S.W 1), at 6 p m—Dr. G. W. Scott-Blair. "Rheology and its Application to Road and Building Materials".

CHEMICAL SOCIETY (joint meeting with the PORTSMOUTH AND DISTRICT CHEMICAL SOCIETY, at the Municipal College, Portsmouth), at 7 p.m.—Dr. H. J. Emeleus, F.R.S.: "Chemical Aspects of Work on Atomic Fission".

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, SCIENTIFIC AND TECHNICAL GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 7 p.m.—Dr. C. F. Powell: "Photographic Methods in Nuclear Research".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 8 p.m.—Dr. C. J. Hackett: "The Clinical Course of Yaws in Uganda", followed by film entitled "Yaws in Uganda".

Friday, October 18

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne)—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATOR IN THE DEPARTMENT OF MEDICAL ENTOMOLOGY—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1 (October 16).

ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY—The Principal, Midland Agricultural College, Sutton Bonington, Loughborough, Leicestershire (October 19).

LECTURERS (2) IN THE DEPARTMENT OF AGRICULTURE, (a) Specialist in Animal Husbandry, (b) Specialist in Crop Husbandry—The Registrar, University College of Wales, Aberystwyth (October 19).

LECTURER IN ELECTRICAL ENGINEERING—The Clerk to the Governors, Technical College, Infirmary Road, Chesterfield (October 24).

JUNIOR LECTURER IN ELECTRICAL ENGINEERING—The Director, Robert Gordon's Technical College, Aberdeen (October 25).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (October 28).

BIOCHEMIST FOR THE PATHOLOGICAL DEPARTMENT—The House Governor, North Staffordshire Royal Infirmary, Stoke-on-Trent (October 30).

DIRECTOR OF RESEARCH of the Wattle Research Institute, Natal University College, Pietermaritzburg, South Africa—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 31).

SENIOR LECTURERS IN (i) PHYSICS, (ii) GEOGRAPHY, (iii) PHILOSOPHY, LECTURERS IN (i) GEOGRAPHY, (ii) PHILOSOPHY, and a JUNIOR LECTURER IN PHYSICS, for Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 31).

ASSISTANT PROFESSOR FOR THE DEPARTMENT OF PHYSICS—The President, Dalhousie University, Halifax, Nova Scotia, Canada (November 1).

DEPUTY DIRECTORS (2) OF ROAD RESEARCH, and a SENIOR PRINCIPAL SCIENTIFIC OFFICER, in the Road Research Laboratory of the Department of Scientific and Industrial Research—The Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1648 (November 7).

DIRECTOR OF ORDNANCE FACTORIES (ENGINEERING)—The Secretary, Ministry of Supply, Est. 8, Room 151, Shell Mex House, Strand, London, W.C.2 (November 14).

CHAIR OF CHEMISTRY at Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (November 15).

PROFESSORSHIPS IN (i) MATHEMATICS, (ii) PHYSICS—The Registrar, University College, Leicester (November 16).

CHAIR OF CHEMICAL ENGINEERING—The Registrar, University, Sydney, N.S.W., Australia (December 31).

PROFESSOR OF BOTANY at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (December 31).

ASSISTANT (female) IN THE CLINICAL LABORATORY—The House Governor, Queen Elizabeth Hospital, Birmingham 15.

ASSISTANT EXPERIMENTAL OFFICER at the Atomic Energy Research Establishment of the Ministry of Supply—The Secretary, Ministry of Supply (Est. 8 (c)), Room 193, Shell Mex House, Strand, London, W.C.2.

ASSISTANT LECTURER IN PHYSICS, and a DEMONSTRATOR IN PHYSICS—The Registrar, University College, Nottingham.

HEAD OF THE DEPARTMENT OF CHEMISTRY AND BIOLOGY at the Leeds College of Technology—The Director of Education, Education Office, Leeds 1.

LABORATORY SUPERINTENDENT FOR THE MEDICAL DEPARTMENT of the Government of Nigeria—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/17075.

LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Principal, Technical College, Huddersfield.

LECTURER IN ZOOLOGY, and a ASSISTANT LECTURER IN ZOOLOGY—The Secretary, University, Edmund Street, Birmingham 3.

SCIENTIFIC ASSISTANT—The Director, Imperial Bureau of Soil Science, Rothamsted Experimental Station, Harpenden, Herts.

SCIENTIFIC AND EXPERIMENTAL OFFICERS FOR THE STATISTICAL DEPARTMENT—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 24 (N.S.), No. 6: Biochemical Analyses with the Spekker Absorptiometer. By Einhart Kawerau. Pp. 63-70. 1s. Vol. 24 (N.S.), No. 7: The Possibility of Initiating Thermo-nuclear Reactions under Terrestrial Conditions. By Dr. J. H. J. Poole. Pp. 71-76. 1s. Vol. 24 (N.S.), No. 8: The Mechanism of the Formation of Allophanates from Carbamates. By A. E. A. Werner and J. Gray. Pp. 77-84. 1s. Vol. 24 (N.S.), No. 9: Dopplerite in Co. Limerick. By M. Dee and G. F. Mitchell. Pp. 85-88. 6d. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1946.) [165

British Library of Political and Economic Science. Annual Report, 1944-45. Pp. 18. (London: London School of Economic and Political Science, 1946.) [215

Medical Research Council: Industrial Health Research Board. Report No. 89: Artificial Sunlight Treatment in Industry; a Report on the Results of Three Trials—in an Office, a Factory and a Coal-mine. By Dr. Dora Colebrook. Pp. 64. (London: H.M. Stationery Office, 1946.) 1s. net. [215

Proceedings of the Aristotelian Society. New Series, Vol. 45: Containing the Papers read before the Society during the Sixty-sixth Session, 1944-1945. Pp. xxv + 206. (London: Harrison and Sons, Ltd., 1945.) 25s. net. [215

Other Countries

State of Illinois: Department of Registration and Education, Division of the Natural History Survey. Bulletin, Vol. 21, Article 5: Preliminary Studies on Parasites of Upland Game Birds and Fur-Bearing Mammals in Illinois. By W. Henry Leigh. Pp. iv+185-194. Bulletin, Vol. 21, Articles 6-7: Preliminary Investigation of Oak Diseases in Illinois, by J. Cedric Carter; A Needle Blight of Austrian Pine, by Robert L. Hulbary. Pp. iv+195-236. Bulletin, Vol. 21, Article 8: Duck Food Plants of the Illinois River Valley. By Frank C. Bellrose, Jr. Pp. iv+237-280. Bulletin, Vol. 22, Article 1: The Plant Bugs, or Miridae, of Illinois. By Harry H. Knight. Pp. vi+234. Bulletin, Vol. 23, Article 1: The Caddis Flies, or Trichoptera, of Illinois. By Herbert H. Ross. Pp. vi+326. Bulletin, Vol. 23, Article 2: Duck Populations and Kill, an Evaluation of some Water-fowl Regulations in Illinois. By Frank C. Bellrose, Jr. Pp. iv+327-372. Bulletin, Vol. 23, Article 3: Overfishing in a Small Artificial Lake, Onized Lake near Alton, Illinois. By George W. Bennett. Pp. iv+373-406. Bulletin, Vol. 23, Article 4: Wetwood of Elms. By J. Cedric Carter. Pp. vi+407-448. Bulletin, Vol. 23, Article 5: Fox Squirrels and Gray Squirrels in Illinois. By Louis G. Brown and Lee E. Yeager. Pp. vi+449-526. (Urbana, Ill.: Illinois Natural History Survey, 1940-1945.) [193

Arkiv for Kemi, Mineralogi och Geologi utgivet av K. Svenska Vetenskapsakademien. Band 22A, No. 10: Electrophoresis by the Moving Boundary Method, a Theoretical and Experimental Study. By Harry Svensson. Pp. 156. (Stockholm: Almquist and Wiksells Boktryckeri A.-B., 1946.) [253

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 34: The Analysis, Grading and Utilisation of Indian Linters. By Dr. L. Thoria and Dr. Nazir Ahmad. Pp. 24. (Bombay: Indian Central Cotton Committee, 1943.) 1 rupee. [283

Annual Report of the Imperial Council of Agricultural Research, 1944-45. Pp. 45. (Delhi: Manager of Publications, 1945.) 2.2 rupees; 3s. 6d. [283

Western Australia: Department of Mines. Report of the Mineralogist, Analyst and Chemist for the Year 1944. Pp. 32. (Perth: Government Printer, 1945.) [24

Pražské Hvězdárny. Č 12: Sur une nouvelle construction de microphotométrie de l'Observatoire de Praha, par František Link; Tables pour la réduction des époques à l'année siderale, par Vladimír Guth. Pp. 14. Č 13: Knihovna astronoma Antonína Strnada ředitele Pražské Hvězdárny (1746-1799). By Otto Seydl. Pp. 78. Č 14: Dioptrische Tafeln der Erdatmosphäre. Von František Link und Zdeněk Sekera. Pp. 28. Č 15: Messungen der atmosphärischen Absorption auf terrestrischer Basis. Von Vladimír Guth und František Link. Pp. 5. Č 16: Über die Fehler einiger Astronomischen Objektive und Spiegel. Von Bohumil Šternberk. Pp. 14. Č 17: Tafeln zur Berechnung der galaktischen Bewegungskomponenten der Sterne. Von František Link. Pp. 48. (Praha: Státní Hvězdárna, 1939-1941.) [34

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau central de Magnétisme terrestre. Tome 19: Publiées par les soins de Prof. Ch. Maurain. Pp. v+183. Tome 20: Publiées par les soins de J. Coulomb. Pp. v+163. Tome 21: Publiées par les soins de J. Coulomb. Pp. iv+145. (Paris: Presses universitaires de France, 1941-1943.) [44

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Indian Forest Leaflet No. 74: The Vegetable Tanning Materials of India, Part 3, Babul (*Acacia arabica* Willd.). By M. V. Edwards. Pp. ii + 21. 8 annas. No. 76: The Vegetable Tanning Materials of India, Part 5, Black Wattle (*Acacia mollissima* Willd.). By M. V. Edwards. Pp. ii + 22. 8 annas. (Dehra Dun: Forest Research Institute, 1945.) [84

League of Nations. Bulletin of the Health Organisation, Vol. 11: Bibliography of the Technical Work of the Health Organisation of the League of Nations, 1920-1945. Pp. 235. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1945.) 6s. [114

Annals of the New York Academy of Sciences. Vol. 46, Art. 6: Surface Active Agents. By M. L. Anson, R. R. Ackley, Earl K. Fischer, David M. Gans, M. H. Hassialis, Rollin D. Hotchkiss, Donald Price, A. W. Ralston, Leo Shedlovsky and E. I. Valko. Pp. 347-530. (New York: New York Academy of Sciences, 1946.) 2.25 dollars. [154

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THE BALANCE OF SCIENTIFIC MAN-POWER IN BRITAIN

IN October 1944 the Standard Oil Development Co. in America made its silver anniversary the occasion for a "Forum on the Future of Industrial Research". The proceedings were issued by the Company in the following year in book form, and the volume makes interesting reading at the present time in view of topical discussions and trends in Great Britain. The papers and discussions centred round three themes: what should be the guiding principles and objectives for the commercial programmes of industrial research and development organisations; how small business can serve itself and be served by industrial research and development, and the place industrial research and development organisations should allocate to future work directed primarily toward national security. They thus canvassed questions that were afterwards discussed in Dr. Vannevar Bush's report, "Science: the Endless Frontier", and one discussion at least covered the same theme as that of the conference arranged by the Manchester Joint Research Council for October 16, 1945, on "Research and the Smaller Firm".

What stands out from these discussions to a British observer is, first, the recognition of the overwhelming importance of a supply of scientific man-power of the highest quality; and secondly, a distrust, which sometimes seems to be carried much too far, of Government-organised or -sponsored research. Nowhere could there be found clearer recognition that both industry and the universities must have their share of the best scientific minds of a country. Industry itself would quickly suffer if by financial inducements or other means it succeeded in attracting into its direct service so many of the first-class men of science that both teaching and research at the universities was left largely in the hands of less able men.

While this is generally recognized in the discussions at this 'forum', American opinion, so far as represented there, appears to be content to leave the distribution to chance and to shy at any attempt to lay down a system of priorities or control. Moreover, while, as was demonstrated at the 'forum', the research association movement in Great Britain has inspired certain co-operative developments in the United States, those developments have taken the form of trade associations or co-operative groups, such as the Institute of Paper Chemistry and the New England Industrial Research Foundation, quite independent of State support. Even the paper on the United States Government research agencies presented by Dr. W. C. Schroeder could not dispel the veiled distrust of Government research which was apparent.

That distrust doubtless owes something to the absence in the United States of the tradition and high standards of the British Civil Service, which bring their own contribution to the building up of a Scientific Civil Service such as is now proceeding. But both in Britain and in the United States, the mere recognition that the first problem in industrial research or in academic research is to secure men of the highest quality, and then to provide them with the conditions which are most stimulating to creative work, will not by itself avert competition between industry and the universities, if not with the Government service also, for such men; and such competition might easily have disastrous results. We cannot leave the matter just where it has been left by the report of the Barlow Committee on Scientific Man-power. Moreover, all four of the 'working parties' that have so far reported testify to the backwardness of certain sections of British industry in regard to research—indeed, it is difficult to see that the Working Party for the Boot and Shoe Industry has itself any clear conception of what really constitutes research as distinct from what industrialists in the United States commonly call 'trouble-shooting'. Further, the able statement on research in the report of the Working Party for the Cotton Industry calls into question the whole basis of the research association from the point of view of utilizing most effectively the resources of man-power and material available for research. That proposal presumably emanates from the Research Sub-Committee, which included, besides its academic members, men like Mr. J. T. Marsh and Mr. J. Baddiley, with long experience of industrial research; and accordingly must be taken as *prima facie* evidence of the existence of some doubt as to whether the effort being expended in the research associations would not yield greater results in some other way. The Pottery Working Party referred to a widespread feeling of dissatisfaction with the achievements of the research associations. If there are any foundations for such doubts, the whole question should be explored without delay. It is known that the Department of Industrial and Scientific Research has plans in hand for a considerable expansion of the research association movement, and besides the proposals from the Cotton Working Party there have been others from the working parties for the pottery and for the hosiery industries which involve expansion in that direction. Before such developments are allowed to compete with the universities and with private industry for the limited supply of available scientific man-power, we should be quite clear as to the way in which that man-power can be most effectively utilized from the national point of view.

Dr. Roger Adams, in the 'Forum' already mentioned, well emphasized the two-fold dependence of industry upon the universities, both for the fundamental research which is the basis of all applied science, and for the supply of trained scientific workers for the conduct of research within industry and of those capable of understanding and applying to the purposes of industry the results of such research. That has equally well been put in the reports of the 'working parties' in Britain for the pottery and the hosiery industries as well as for the textile industry. The need for a widely interpreted reciprocal relation between science and industry; the importance of having enough men of high ability trained to do the necessary scientific work; the impossibility of science making its true contribution to industrial progress unless research workers create an organised body of knowledge relating scientific theory with industrial practice, and unless industry on its side has enough men in high positions who are capable of understanding scientific principles—these points, explicitly stated in the report on the cotton industry, are equally implicit in those for pottery and hosiery.

The Working Party for the Hosiery Industry is well aware of these relations and of the wide field for research which now confronts the industry, but none of its recommendations indicates that the importance of the quantitative factor to which Dr. Roger Adams referred is fully appreciated: the danger that at the present time the better conditions which industry is able to offer may deplete the university departments of their ablest and most promising men, both in research and in teaching. The development of the Wool Industries Research Association Station in Nottingham into a Hosiery Research Institute, the establishment of a Hosiery Research Council and a Hosiery Design Centre, the imposition of a compulsory levy upon a yarn-usage basis on all hosiery manufacturers and the establishment with other textile industries of a general textile research organisation, are excellent things; as are also the promotion of close relations between the Hosiery Research Council and Institute with the universities, technical colleges, textile and other professional and scientific institutes, research associations, etc., and development of an efficient industrial relations service to ensure the widest dissemination of research findings among industrialists who are expected to apply and develop them. But recommendations such as these, however excellent in themselves, may well be ineffective unless we grapple with the real core of the problem of this potential competition between the universities, industry and the Government departments for scientific workers. Moreover, to implement the further recommendation that the Hosiery and Knitwear Council considers seriously the establishment of some organisation for the hosiery industry that would be responsible for the collection, collation and publication of the results of research in the economic and sociological fields, the maintenance of contact with professional and scientific research institutions concerned with these fields, including the universities, and the pursuit of such research on its own account, presupposes further demands on the universities for trained workers in much the same field as the proposals of the Clapham Committee.

A fresh appraisal of the whole research association movement, and particularly its relation to the universities and the research departments of individual firms, may be an essential element in planning the adequate distribution of man-power resources in Great Britain. It might also be valuable in dispelling some of the false ideas regarding the function of the research association to which the Potter Working Party refers. Any vigorous industry wit private research establishments, that report poin out, moves rapidly ahead of its co-operative researc associations in knowledge of the application scientific work. The function of the research associ tion should be continuously to unfold the fundamental scientific background of the industry, reaching into many different fields of scientific knowledge. The Pottery Working Party urges that all large potteries should have private research departments, but it recommends also a statutory levy on all pottery firms to provide the funds for co-operative fundamental research, and it inclines to the view that contributions to the research association should be split into two parts, one—compulsory—used to support fundamental research, and the other—voluntary—to finance co-operative technical consul ing service.

An inquiry into the research association movement should give an indication of the magnitude of the justifiable demand from that quarter for scientific talent. Correspondence in *The Times*, flowing in part from an article from Sir Ernest Simon and two subsequent articles on the universities of Great Britain, has pointed to some doubts as to the extent of the demand of industry on the universities for trained man-power. Sir Ern st Simon accepts the contention of the Barlow Report that the task set before the universities is to double their output of students in ten years, with a large expansion of research in all fields; but Sir Cyril Norwood has questioned the soundness of some of the assumptions of the Barlow Committee as to the numbers of potential students not yet reaching the universities, and the capacity of business and industry to absorb a greatly increased number of graduates.

It must be admitted that, in spite of the work of the Hankey Committee, the Ministry of Labour and National Service has provided no convincing evidence that the professions and industry generally can absorb a much larger number of graduates, and some of the experience of the appointments department is disturbing, particularly the high level of current unemployment among technical specialists in certain occupations. Even if employers generally do not make all the use that they might of appointments offices, the existence of so much unemployment among highly qualified men, particularly those more than forty years of age, cannot altogether be disregarded in considering the scale of university expansion. None the less, it is reasonable to anticipate an increased and sustained demand for graduates alike for scientific research, in industry and business, in the Government service and in professional appointments of all kinds at home and overseas. The crucial problems unfolded in this correspondence lie rather in the means by which the development of the universities to provide this larger supply of graduates is to be implemented. The difficulties found by the Universities of Oxford and Cambridge in expanding to the degree desired have led Lord Cherwell to propose the transfer of engineering training from the universities to degree-giving institutes of technology, and a like proposal has been made that cities such as York, Bath and Norwich should be made centres of university education devoted to a special subject or related group of subjects. Such proposals have been rightly criticized as inconsistent with the whole ideal of university education. Sir Charles Grant Robertson has pointed out that a start could well be made by bringing existing university colleges such as Nottingham, Southampton and Exeter to full university status, and powerful support has been forthcoming for the view that not segregation of subjects or studies but a closer integration of the humanities and the sciences in university education, and an attempt to reconcile the need for breadth of understanding and sympathy with the need for specialization, are imperative to enable the universities to provide men and women of the type required in the world to-day.

The case for and against a Royal Commission to examine the whole aims and problems of university education in the world to-day has been argued both from that point of view and also from that of planning the development of the universities when the immediate post-war stress is relaxed. Even those most confident in the ability of the University Grants Committee, as it is now reconstituted and with its wider terms of reference, to handle all the problems of development and co-ordination that will arise, seem a little uncertain as to whether something more, at least an inter-university academic council, is required to ensure the maintenance of independence, in view of an obvious danger of bureaucracy and regimentation, while securing the co-operation in development that the grant of public aid on such a greatly increased scale rightly implies. It may be that the universities have yet to find the best form of co-operation in practice, but something more is required in addition to the creation of effective machinery to prepare a general plan of university development with generous Government financial support.

The implementation of such a plan requires a measure of co-operation between industry, the universities and the Government service in regard to the distribution of man-power in order to realize its purposes. It is not sufficient for the universities themselves to make appropriate adjustments between their teaching and research staff, or to secure that, as the Cotton Working Party insists, they have complete freedom as regards the scope and direction of fundamental research carried out in their laboratories. It is not even enough for individual firms to recognize that, for the time being, universities must be conceded priorities in regard to men for research and for teaching. A system of priorities in man-power, such as is indicated in the Barlow Report, cannot be left altogether to chance. It must be reviewed continually in the light of the changing situation, or of such appraisals as that suggested of the research association movement. When priorities are laid down authoritatively, there must be some means of ensuring that, without placing irksome restrictions on the movements of scientific workers themselves, conditions of service and remuneration are so balanced, as between the universities, private firms and Government departments, that there is no untoward impediment to the natural flow and distribution of scientific talent in accordance with the national interest. It would scarcely be possible in peace-time to impose restrictions that would prevent sectional interests, whether private firms or Government departments, attracting to their service by reason of prestige or of financial advantage, some few scientific workers who, from the national point of view, might be better employed, for example, in academic research or teaching, without adversely affecting the mobility and interchange of men of science which the Barlow Committee on scientific staff recognizes as so valuable. The growing dependence of the universities of Britain on State support should, however, make it increasingly easier for the Government to ensure through the Royal Society or the University Grants Committee that conditions in the universities and in Government departments are sufficiently in balance with those in industry to maintain a steady and adequate stream of recruits of the highest quality.

ESSAYS IN NEW ECONOMIC TECHNIQUES

The Industrialisation of Backward Areas

By K. Mandelbaum, assisted by J. R. L. Schneider. (Institute of Statistics, Monograph No. 2.) Pp. viii+112. (Oxford: Basil Blackwell, 1945.) 10*s*. 6*d*. net.

Small and Big Business

Economic Problems of the Size of Firms. By Joseph Steindl. (Institute of Statistics, Monograph No. 1.) Pp. v+66. (Oxford: Basil Blackwell, 1945.) 7*s*. 6*d*. net.

MR. MANDELBAUM'S volume is a fascinating essay in quantitative planning of a type of which we may expect many examples in coming years. Poland, Hungary, Bulgaria, Rumania, Yugoslavia and Greece are to be industrialized at a rate surpassing that experienced in the leading industrial countries in the nineteenth century. The implications—income distribution among various classes, rates of growth of the various categories of industry, capital requirements for each, etc.—are worked out in considerable detail. In a sense the detailed figures are mere guesses, but they are based on good analogies, and there is an element of double entry present which serves as check. The work is scholarly, and in its quantitative aspect authoritative. Human, social and political difficulties are admittedly neglected.

Technical assistance is to be provided from abroad and £750 million of capital spread over five years; this represents more than half the new capital required It is suggested that the foreign sources will charge the modest rate of 4 per cent per annum, to include interest and amortization. When one thinks of the sweat and toil and horrors of the Industrial Revolution in Britain and the ardours and starvation during the recent Five-Year Plans in Russia, one cannot but feel a little wistful—which is not the same as critical—at this proposed journey de luxe by South-East Europe to an increase of 50 per cent in its national income in no more than five years.

There are matters for criticism There is no demographic 'model' to supplement those for production. An increase of 400,000 a year in the population is assumed. As one of the primary objects of the plan is to find employment for 8,000,000 hands at present surplus, there are grounds for anxiety about the future equilibrium. The birth-rate in these regions has been falling recently, but is still above the replacement level. It may be that the fall will continue down to Western European levels and that industrialization is likely to expedite the process None the less one would have liked a full analysis both of birth- and death-rate trends with a view of forming some estimate of the total increase that may have to be catered for. Mr. Mandelbaum's methods may well be used as a model for plans regarding India and China; but in the case of those countries a demographic forecast is essential. Even if one takes the optimistic view that under the influence of industrialization the birth-rate in India and China will eventually reach, say, the American level, the fall in the death-rate owing to improved conditions is likely to cause such a vast increase of population during the transition as to reduce the whole experiment to absurdity—unless deliberate measures are taken in advance to reduce the birth-rate

Mr. Mandelbaum's chart of industrialization is not a forecast but a plan. Private enterprise, it is recognized, is not likely to bring it about, even if stimulated by the protection of infant industry. The governments are expected to play an active part. This may well be necessary When, however, Mr. Mandelbaum recommends deficit spending as a method, he errs gravely. Deficit spending has recently become a popular nostrum; but it has a firm foundation in scientific analysis, in the light of which its merits depend on there being in the country an excessive propensity to save. To take it out of its context and recommend it for countries where, by hypothesis, savings are altogether insufficient to meet urgent requirements is quite unjustifiable. It is much to be hoped that when the International Bank for Reconstruction and Development comes to formulate the conditions on which it will guarantee large loans for long-range projects—and South-Eastern Europe is clearly an eligible candidate for such loans—one condition will be that the government of the receiving country is not running an appreciable deficit.

The economic trends are applied too mechanically. When dealing with rates of progress outside experience it is necessary to consider whether the social adaptability of any people can stand such a strain. Furthermore, it is necessary to inquire whether the south-eastern European peoples in particular have capacity for work, technology and organisation—even with the aid of foreign assistance—that would be necessary for the plan. Their present backward condition is *prima facie* evidence of a deficiency of such qualities. It may, of course, be due, as Mr Mandelbaum suggests, to political misfortunes and the competitive start gained by other countries. But this cannot be taken for granted.

Further, there is a deeper criticism. By what criterion is this development desirable? Is it enough to demonstrate that the standard of living would be raised? Economists are often taken to task for assuming without warrant that the maximum production of material goods should be our paramount aim. Careful economists are not open to the charge, since they introduce "the disutility of labour" or "the preference for leisure" as a determinant in their equations defining the economic optimum. From a Western point of view the impoverished and semi-employed condition of the south-eastern European peasantry may seem lamentable and pitiable. Mr. Mandelbaum would have their governments make a great drive to retrieve them. His scheme is an imposed plan; there is no safeguard enabling the people to opt in favour of a peaceful life. It is ominous that Mr. Mandelbaum at one point is willing without sign of qualm to throw in double or multiple shift working to facilitate the progress of the plan. Will these peasants be happier living in urban dwellings, built at a cost of £175 each, and working through the night in a mill? The old economics insisted on freedom of choice in theory, although in many cases it was admittedly unreal in practice. It is a weakness, however, to give up the theory.

Mr. Steindl's monograph is nearer to reality and is of great immediate interest. Using American statistical data as a basis for generalizations regarding the relations of size, cost, efficiency and profit in business, he analyses the implications and mutual consistency of the generalizations with great skill. The trend of the argument is in favour of large size; on the other hand, when a certain size is reached, monopolistic or oligopolistic features in the situation may tend to retard progress. "There are sufficient grounds to believe that the cause of technical progress in the present stage of development is not well served by either big or small business. There seems to be something wrong with both of them."

Mr. Steindl has a fine mastery of analysis, and his book is an outstanding contribution. There is a small slip on pp. 37–38. He is right in holding that if we accept Keynes' theories there is no need in the existing situation to reckon interest on capital in, when measuring relative efficiencies; but he is wrong in implying, as he appears to, that we need not reckon in the amortization of capital either. The resources required for increasing capital intensity could always be spent on current consumption; their absorption is a genuine cost.

It must be recorded that in this volume, too, the human factor is neglected, less obviously but this time without any safeguarding disclaimer. Searching about for a reason why small entrepreneurs accept unusually high risks at low remuneration rather than become employees, Mr. Steindl lights upon the explanation that it is to maintain "a higher social status". It would be difficult to find a more striking example of complete disregard of the passions and values that animate ordinary people outside the study. Again, when persons prefer to deal with old customers, this is due to "force of habit, ignorance or laziness". This is the economic steam-roller with a vengeance! Luckily economic wants are not so pressing in the United States (from which the data for this study are derived) that people must needs sacrifice the more precious things of life in order to add somewhat to material income. Even the poor British may have some little room for non-economic aims.

TEXT-BOOK OF OPTICS

Optique Instrumentale

Par Prof. G.-A. Boutry. Pp. x + 540. (Paris: Masson et Cie., 1946.) n.p.

THE strength and spirit of the contemporary renaissance in French optics can be felt behind this admirable book, which carries its subject through more than five hundred pages without allowing the interest to flag. As the author explains in a preface, the treatment is based on his course of lectures in instrumental optics, given at the École supérieure d'Optique. Side by side with this course, the students receive another on optical computation, which subject is therefore omitted from the present treatise. For a similar reason, namely, the existence of Danjon and Couder's "Lunettes et télescopes", astronomical optics is only briefly dealt with. What is left, that is to say the main body of the subject, is set out with skill and enthusiasm in twenty-two chapters, of which the last six are separate monographs.

Perhaps the most valuable of these monographs is the one which treats of the visual microscope. Objective, illuminating system and mounting are given equality of status in the discussion, which is refreshingly practical in outlook. An account of the phase-contrast method is included, but this is below the standard of the rest of the chapter; Zernike's name is consistently misspelt in the text, and the captions of Fig. 340(*b*) and (*c*) are misleading. These two photographs actually illustrate the appearances with a 'positive' (that is, phase-advancing) annular strip and a 'negative' straight strip, and were used by Zernike in support of his view that for most purposes the annular form of strip is preferable.

In the first seven chapters of the book, the basic theory of centred systems is developed, always with an eye to practical application, from its beginnings through Snell's law (Descartes' law), focal lines and caustics, the Herschel and Abbe conditions, Airy's condition and the properties of spherical aberration and coma. Mathematical demands on the reader are kept down to the minimum throughout and no systematic account of the Seidel theory is attempted. Considerable space is devoted, on the other hand, to the details of Gaussian theory and its application to thick lenses. Chapters 8 and 9 set out the principles underlying the practical designing of achromatic doublets and of eyepieces.

The next three chapters deal with prism-trains and with cylindrical systems. An incorrect theorem on p. 217 (to which M. Boutry has directed the attention of reviewers) fortunately has no serious consequences later.

Chapters 13 and 14 are devoted to the human eye and the amelioration of its defects; a welcome feature is the short but valuable section on visual acuity. Chapter 15 is of a more miscellaneous character; under the title "geometrical properties of visual instruments" are discussed such questions as field-size, depth of field, perspective and relief, and image-brilliance in different parts of the field.

The main part of the book concludes with a chapter on resolving power. In its lucidity of exposition, and in the ground it succeeds in covering with the help of very little mathematical formalism, this chapter is one of the most striking in the book. Especially helpful is the way in which the author himself raises and tries to meet the honest doubts which are likely to assail a thoughtful student confronted for the first time with the Huyghens–Fresnel theory.

The attitude to the subject which vitalizes the whole book is expressed in a few pregnant sentences in the preface, which are worth quoting here. After pointing out that students must contrive to assimilate in succession the two very different outlooks of geometrical and of instrumental optics, M. Boutry goes on: "Leur préparation est complète dès que, rompus et assouplis, l'expérience et l'expérience seule aura pu leur enseigner la manière dont on doit, en pratique, fondre les deux dogmes. Aucun autre professeur ne peut terminer leur formation: c'est confesser peut-être que l'Optique instrumentale reste un art; cela ne diminue point les hommes qui la créent chaque jour."

E. H. LINFOOT

BIOLOGY IN SOVIET RUSSIA (1917–42)

Advances in Biological Sciences in the U.S.S.R. within the Recent 25 Years, 1917-1942

Symposium. Editor-in-Chief: L. A. Orbeli. (In Russian.) Pp. 356. (Moscow and Leningrad: Academy of Sciences of the U.S S.R., 1945.) 26 roubles.

THIS volume, compiled by some thirty authors, represents an attempt to summarize the work in the main branches of 'pure' biology, carried out in Soviet Russia during the period 1917–42. The summaries cannot be called critical, and their main aim is made abundantly clear by the introductory sentences to each section, which all plainly stress, in monotonous similarity of words, that the blossoming out of every particular branch of biology followed the Revolution and was due to the Soviet attitude to science Completeness of the record of achievements is not claimed in the preface, which indicates that war-time difficulties made it impossible to obtain summaries of the work in a number of biological sciences. As a result, the volume lacks summaries on geology, experimental biology and genetics, to mention only the most conspicuous gaps.

Individual contributions vary from comprehensive reviews of the main results obtained by Soviet scientific workers in a particular branch of biology, to mere lists of authors and subjects. Such lists might have been of great value to men of science of other countries, but unfortunately throughout the volume no references are given, except by the author's name and the date; a number of, apparently, important papers are quoted from manuscript. An accurate bibliography of all the publications mentioned in the text would have, probably, occupied fewer pages, while supplying an incomparably more useful record of the progress of Soviet science. The need for such bibliographical work is pointed out in the conclusion to the summary on zoological systematics and faunistics, where it is stated (p. 183) that ". . . the recognition of achievements of Soviet science is not always proportional to the actual value of the work; we often meet with an under-estimation which has a political basis and is due to unwillingness to draw attention to achievements of Soviet science in particular. However, in many cases, the underestimation of achievements of Soviet science is, so to speak, due to technical reasons, for example, simply to the lack of knowledge about the respective works, and in many cases the fault is ours." A footnote explains that in 1937 only about 25 per cent of Russian papers were quoted in the *Zoological Record*, whereas in 1913 the percentage was about 50. This is ascribed to the interruption of the work of the Bureau of International Bibliography at the Academy of Sciences, a point worthy of the attention of international bodies concerned with scientific bibliography.

It would be impossible to review all sections of a volume of this kind, but brief indications of the main items may be useful.

The section on physiology contains articles by L. A. Orbeli, A. G. Ginecinsky, A. V. Tonkikh and M. I. Vinogradov, on nervous physiology; by N. P. Rezviakov on electrophysiological investigations; by A. G. Ginecinsky on vegetative processes; by G. V. Gershuni on sense physiology; by E. M. Kreps on comparative physiology; and by A. G. Ginecinsky on physiology of embryos.

Advances in biochemistry are summarized by V. A. Engelhardt, who stresses that the development of this branch of science in Russia has occurred almost entirely during the Soviet period.

The chapter on animal systematics and faunistics, by twelve authors, is the longest in the volume and consists mainly of an enumeration of books and papers dealing either with taxonomic groups or with various local faunas. The lack of references in this section is particularly serious, since it helps a taxonomist little to know that a revision of a genus in which he is particularly interested was published by a Russian author in 1938, if there are no means of finding a reference.

As already stated, a summary on geological work is missing, and only palæontological achievements are reviewed by A. A. Borisiak (palæozoology) and by A. N. Krishtofovich (palæobotany).

Botanical sciences are represented by summaries on systematics and floristics, by B. K. Shishkin; on plant ecology, by E M. Lavrenko; on plant physiology, by N. A. Maximov, and on microbiology, by B. L. Isachenko.

The last section of the volume deals with the theoretical principles of medicine, and includes summaries by A. I. Abrikosov (pathological anatomy), N. N. Petrov (malignant growths, especially cancer), and N. N. Anichkov (pathological physiology).

INTRODUCTION TO ALTERNATING CURRENT MEASUREMENTS

Alternating Current Measurements at Audio and Radio Frequencies

By Dr David Owen. (Methuen's Monographs on Physical Subjects.) Second edition, revised. Pp. vii + 120. (London: Methuen and Co., Ltd., 1946.) 5*s*. net.

THE present author maintains the quality of the many preceding monographs on basic up-to-date physics, but does not quite give that aspect the electrical engineer requires, although the material may be ideal for educational purposes in *ad hoc* physics. The practising engineer looks on electrical measurements as a tool to enable him to do something else, to get data to assist him in solving his problems. Thus, while the author gives an excellent survey of the basic circuits which are usable for the regular measurements of the usual electrical parameters, including frequency, with their proofs, he is not always clear in describing their limitations, especially when measurements above 1000 cycles per second are demanded. While he gives a clear exposition of the principle of the Wagner earth, he nowhere else insists on an earth connexion to a suitable point in his circuit; neither is the reader warned about the necessity of shielding inductances and other components, and told where the shield should be connected. All these are vital practical points affecting the possibility and accuracy of an electrical measurement.

Nevertheless, within his scope the author has laid foundations which should put a student in a good position to understand the basis of practice when he meets it in non-educational laboratory work, and should prompt him to exercise ingenuity in devising measurements when he is faced with the usual problem in industry, the paucity of high-grade measuring apparatus.

L. E. C. HUGHES

EXPANSION OF PLANT SYSTEMATICS

THE Systematics Association held a very successful meeting at the Herbarium, Royal Botanic Gardens, Kew, on the afternoon of October 5 Members were welcomed by Sir Edward Salisbury, director of the Gardens, who briefly outlined the long service of Kew to plant taxonomy and the intimate co-operation between the various departments with the common aim of advancing research in the many problems of plant classification. He was pleased to see such a large attendance, and was certain that the exhibits so carefully prepared by members of his staff would arouse much interest

The theme underlying the series of exhibits was to illustrate examples of the diversified problems involved in plant systematics, the various methods of investigating such problems, and some of the results obtained. The exhibition occupied the ground floors of two of the large wings of the Herbarium, and consisted of living plants, herbarium and museum specimens, microscopic preparations, books, manuscripts, diagrams, charts, and maps, with considerable and pleasing individuality shown in the arrangement of the various subjects. In spite of the intentionally wide range covered by the sum of the exhibits, the general *motif* of plant classification obviously unified the whole series.

The history of the progress of botanical taxonomy from 370 B.C. to A.D. 1946 was illustrated by a collection of books and manuscripts selected from the Kew Library, which now contains more than 50,000 volumes. Many rare and valuable works were shown, and emphasis was laid on those which marked noteworthy advances in plant classification. Another series of botanical books (about thirty in number altogether) showed something of the activities of the Kew staff in very recent years. Attention was directed to the large exhibition of paintings and drawings demonstrating the history of botanical illustration from 120 B.C. to A.D. 1946. A selection of original paintings for the *Botanical Magazine* and of paintings of dissections of plants difficult to preserve adequately showed the value of hand-colouring in the making of permanent records of living plants. The importance of drawings in the revision of genera was exemplified by *Sphæranthus*, *Camellia*, and *Streptocarpus*. A selection of original drawings, with dissections, for a new work on the British Flora now in preparation were remarkable for their combination of artistic merit with scientific accuracy and adequacy.

Two large families, those of the orchids and the grasses, served to illustrate the difficulties of classification due to incomplete correlation in different categories of characters. In *Polystachya*, a large genus of Orchidaceæ, only some of the accepted sections are natural in the sense of being based on a full correlation of characters. Other sections are distinguished by only one or two characters and show much reticulation with other sections. The tribes and genera of the Gramineæ provide even more striking examples of reticulation. This was illustrated by the spicate inflorescence in relation to a wide range of other morphological, anatomical, and cytological characters. The emphasis, in earlier classifications of the grasses, on the gross structure of the inflorescence resulted in some very unnatural groupings. By taking a more synthetic basis, a much more generally satisfactory division into major tribes has been obtained, though problems of parallelism and reticulation still remain, especially those of causal and phylogenetic interpretation. *Lepturus* and segregated genera represent particularly well some of the problems involved and their possible solutions. The desirability of major changes in classification was also made clear in the genus *Carex*, which has more than a thousand species Detailed morphological and distributional studies have suggested classificatory sequences which reveal possible phylogenetic lines linking tropical and temperate species Problems of 'relationship' were further demonstrated by the occurrence of similar characters in groups widely sundered in well-known systems of classification. For example: Symplocaceæ, Rosaceæ, and Theaceæ; Anonaceæ and Aristolochiaceæ; Ochnaceæ and Primulaceæ; and Magnoliales, Hamamelidales, Aceraceæ, Platanaceæ, and Lauraceæ respectively show some characters in common. *Pentaphragma* has been referred to both Campanulaceæ and to Saxifragaceæ, and, more recently, has been made the type of a new family, Pentaphragmataceæ, which anatomical characters suggest may be related to Begoniaceæ. On the other hand, a long-established group like the Glumifloræ is probably based on superficial resemblances, particularly of habit: the sedges and rushes are better classified with or near to the Liliales, and the grasses perhaps placed near the Zingiberales. Odour is determined by chemical constituents of plants; similarities in these are, or may be, taxonomically valuable characters. It is, at least, not to be ignored that 'valerian' odour occurs in *Valeriana* (Valerianaceæ), *Viburnum* (Caprifoliaceæ), and *Pentstemon* (Scrophulariaceæ), and the 'fenugreek' odour in *Trigonella* (Leguminosæ) and *Lysimachia* (Primulaceæ).

Similar difficulties to those met with in classifying seed-bearing plants also occur in the Cryptogams, sometimes with further complications. The genus *Psalliota* (the mushrooms proper) consists of 'species' or 'microspecies' extremely difficult to separate one from another by any definite, and constant, characters. With such fleshy organisms, adequate paintings of living plants are essential as permanent records. In the smuts, so-called 'physiological races' occur which are morphologically indistinguishable but are limited to different hosts; while, conversely, on the same host morphologically distinct kinds may occur. Hybridization frequently complicates the work of the taxonomist, and the occurrence of hybrid swarms is being frequently proved The Robertsonian saxifrages, as they occur in western Ireland, were used to exemplify, by a fine series of recently collected specimens, the possibilities of unravelling the tangle resulting from interspecific crossings. The results of controlled hybridization combined with cytological investigation were indicated by living plants, dried specimens, and paintings, in: *Saccharum* × *Sorghum* hybrids; × *Sacchariantlhus coimbatoriensis* ($2n = 132$), a hybrid between *Saccharum spontaneum* ($2n = 112$) and *Erianthus ravennæ* ($2n = 20$); and × *Euchlæzea mertonensis* ($2n = 30$

and $2n = 40$), a perennial hybrid between *Euchlœna perennis* ($2n = 40$) and *Zea mays* ($2n = 20$). Seeds and living plants of *Ricinus communis* from Manipur State showed the genetic nature of certain 'varietal' characters. The cytology of species of *Magnolia* has proved the existence of diploids ($2n = 38$), tetraploids ($2n = 76$), and pentaploids ($2n = 95$), and correlation between the chromosome number, geographical distribution and morphological features.

Taxonomic investigations can only be adequately conducted at a large central institution, since taxonomy is essentially a comparative study, and large series of specimens are a *sine qua non* for reaching sound conclusions. It follows that the taxonomist is dependent in a very large degree on field collectors—and to well-trained collectors he owes a great debt. The need for much more intensive collecting, particularly in tropical areas, throughout the seasons in any one locality was well shown by an exhibit of precocious development in tropical African plants of savanna communities. In many species the flowers and leaves develop at different seasons, and a travelling collector often collects only flowering or only vegetative material. To know the seasonal life-history is a taxonomic need. This was further illustrated by some South American plants with comparisons between seedling and adult states (*Chondodendron candicans*, *Cassia* spp., *Catostemma* spp., and *Apeiba petoumo*). Juvenile characters may, or may not, be apparent in the mature plant, but are always of taxonomic importance. Ontogeny was also illustrated by living sporelings and beautiful microscopic preparations from fronds of different ages of the fern-royal (*Osmunda regalis*). The nature of the venation and the outline changing with increasing age were very clearly demonstrated.

The taxonomist is always concerned with distribution, both as a help in understanding causes and for its own sake. Two exhibits were concerned with plant geography. The phytogeographical regions of extra-tropical Eastern Asia were illustrated by large- and small-scale original maps showing correlations between the ranges of taxonomic groups and plant communities, physiography, and climate. Specimens of *Notholirion*, *Pœonia*, *Nomocharis*, *Malus*, *Tulipa*, *Tripterygium*, and *Camellia* were chosen as examples of the researches on which the synthetic results have been reached. The great sub-continent of India has not only a rich endemic element of its own but also has received floristic contributions from neighbouring lands, especially from the east and north-west Emigrants (generic or specific) from the Eastern Mediterranean flora are well marked in the Cruciferæ, Fumariaceæ, Capparidaceæ, Caryophyllaceæ, Rosaceæ, Labiatæ, and Boraginaceæ. Routes of migration were shown on a map, and migrants selected from the above-mentioned families were used in illustration.

In modern taxonomy, full and carefully prepared descriptions are demanded. Sometimes statistical methods can be applied with advantage. Unfortunately, the combination of taxonomist and biometrician is rare, and few statistical methods have been devised for the special use of the taxonomist. The attention of biometricians might well be directed to this fact. The genus of the elms (*Ulmus*) has recently been investigated by the use of new criteria based on specially devised statistical methods, and an exhibit illustrated these methods and the results obtained by their use.

While much taxonomic work has to be based on gross morphology, there is increasing recognition of the need for correlating this with anatomical structure. Anatomical methods have great use, and some acknowledged limitations, in taxonomy, as have all taxonomic methods in isolation; but the forthcoming publication of a new work, prepared at Kew, on the anatomy of Dicotyledons will stimulate interest in the subject. An exhibit illustrated the diagnostic value of the internal microscopic structure of the leaf, petiole, stem, and secondary xylem, as well as that of microchemistry.

Taxonomists working at Kew are fortunate in having not only the great collections in the Herbarium and Library at their disposal, but also in being able to study a wide selection totalling some 45,000 species (excluding culti-species) in the living condition in the Gardens. The need for experiments, with taxonomic aims in view, on living plants is fully realized, and it is intended to increase facilities in this direction. One exhibit illustrated the need for caution in reaching taxonomic conclusions previous to such experiments. Transplant experiments with *Plantago major* have shown the high plasticity of this species and proved that some so-called 'subspecies' and 'varieties' are no more than 'habitat forms'. In *P. coronopus*, phenotypic diversity is even greater than it is in *P. major*, but until controlled experiments have been made, the separation of genetically distinct varieties and habitat phenotypes of one genotype is impossible.

Taxonomy has to serve all branches of biology—hence its basic importance. A convincing demonstration of its use in applied botany was provided by an arrangement of specimens of *Sorghum* and *Cymbopogon*. The former genus gives one of the world's most important cereals, providing a staple food to millions of human beings as well as to livestock. For many years there was much confusion over the numerous cultivated species and varieties. An intensive and extensive study at Kew resulted in the production of a standard monograph which has been invaluable to economic botanists. *Cymbopogon* is a genus of grasses yielding essential oils. Previous to a detailed taxonomic study, it was not possible with certainty to determine the source of any particular oil derived from a species of *Cymbopogon*.

Particularly striking general features of the exhibition, as viewed by a visitor, were the wealth and diversity of the interesting problems raised by studies grouped as taxonomy, the almost innumerable treasures housed yet accessible at Kew, the considerable progress being made in taxonomic research, and the broad outlook shown by the modern taxonomist, with his full appreciation of the help he can give to and the help he can obtain from his colleagues in other branches of biology. Visitors engaged in the teaching of biology must have received many suggestions.

At the business meeting, the Systematics Association was placed on a firmer foundation than hitherto by the adoption of a simple set of rules. All biologists interested in problems of classification and evolution are invited to join the Association and take part in its increasing activities. Particulars can be obtained from the secretaries: Dr. R. Melville, Royal Botanic Gardens, Kew, Surrey, and Mr. H. W. Parker, British Museum (Natural History), South Kensington, S.W.7, or from the treasurer. Mr. E. B. Britten, British Museum (Natural History).

METHODS FOR MEASURING STRESS AND STRAIN IN SOLIDS

IN present-day engineering design, a stage has been reached when, not content with vastly improved materials and design procedure, the engineer must know the actual stresses throughout the machine or structure when under test, in order that weaknesses can be corrected in production models and avoided in future designs. Thus the designer, by a method of 'successive approximation', progresses towards the ideal of equal life for every part exemplified by Longfellow's famous "One Horse Shay", every part of which collapsed simultaneously after long service.

In aircraft, every pound of unnecessary weight in the engine or airframe means a pound less payload. Consequently, in aeronautical design more than any other branch of engineering, weight must be pared to the very minimum compatible with safety; while, on the other hand, the probability of a fatal accident if some part or other is of insufficient strength is far higher than in other forms of transport. It is axiomatic, too, that greater speed calls for greater precision in design. That safety has not, in fact, been sacrificed for lightness is shown by the fact that not more than 1 per cent of the accidents to civil aircraft are attributable to structural failure.

It is an official requirement that, before a particular aircraft design is approved, the test structure—in particular the wings—must withstand 1·2 times the design load without failure. For this purpose, a prototype is tested in a large straining frame. During the test, as much information as possible is collected about the distribution of stress, so that any possible weakness can be eliminated with the least delay.

Until quite recently, the only apparatus available for measuring strain during test was some form of visual-reading extensometer. The number of stations at which readings could be taken was extremely limited under these conditions, and the process of taking readings very tedious. A desperate need was felt for some type of strain gauge which would enable a very large number of readings to be made in a short time at each stage of loading. This need has at last been met, by the invention of the electrical resistance strain gauge and of the acoustic strain gauge.

The electrical resistance strain gauge has the following great merits: (1) it is very light and compact; (2) it can be placed in almost any position, for example, inside a wing, on thin sheet and curved surfaces; (3) once stuck on, it requires no further attention; (4) no mechanical adjustment is required; (5) electrical recording lends itself to making a very large number of readings in a short time; (6) all readings can be taken at a central control point; (7) it lends itself to autographic recording, and can be used with automatic switching devices; (8) it can be left in position ready for a repeat test at any time; (9) it can be used for recording rapidly fluctuating stress, and is practically free from inertia effects; (10) if three such gauges are combined, owing to the short gauge-length the principal stresses can be computed without previously knowing their directions; (11) if a sufficient number of gauges are used, analysis of the stresses in every part of the structure can be made.

The rapid progress in recent years in the invention of accurate and convenient apparatus for measuring strains played no small part in the improvements in aircraft and other design during the War, and the Manchester Branch of the Institute of Physics arranged a conference on the subject during July 11–13. Technicians in widely different industries have not been slow in following the lead of the aircraft industry in applying the electrical resistance strain gauge to their special problems, and the first session of the conference was devoted to the characteristics and applications of this type of gauge.

It had been the intention to cover not only the gauge itself, but also a full discussion of the electrical systems employed in different circumstances; unfortunately, due to the unavoidable absence of Dr. E. P. George, of the G.E.C. Research Laboratories, and of Mr. A. Cogman, of the de Havilland Aircraft Co., Ltd., comparatively little discussion was heard of the electrical technique*. However, Mr. E. Jones's paper on "The Physical Characteristics of Electrical Resistance Strain Gauges" aroused lively discussion.

Mr. Jones, after mentioning that the change in resistance when a fine wire is strained is only partly due to the changes in dimensions, but also depends on the change of resistivity of the material from which it is made, gave reasons for preferring cupro-nickel to nichrome wire. The latter is not easy to solder, and, due to the greater temperature coefficient of resistance, the temperature matching of nichrome gauges must be fifty times as good as that with eureka. Seventy per cent of the gauges made of eureka wire are found to give linear response up to 5 per cent strain. After describing various methods used for manufacturing these gauges, Mr. Jones discussed the technique required to minimize errors. The gauges are stuck in the prepared positions using cellulose acetate cement. For each measuring gauge, there is a dummy gauge for temperature compensation, mounted on unstressed metal in thermal contact with the test piece. Each pair is selected by matching, so that, by arranging the measuring gauge and the dummy in adjacent arms of a Wheatstone bridge, and applying a suitable voltage, the gauge resistance is compensated for temperature changes. To prevent serious zero drift, the gauge current should not exceed 35 milliamp. in static tests, but for dynamic tests larger currents are permissible. For high-precision measurements, as for observing wind-tunnel forces, the current is limited to 5 milliamp. It is always necessary to allow sufficient time (say half an hour) after switching on the current for a steady condition to be established. In practice, an extension of 1 per cent in metals is seldom measured. The upper limit of frequency for accurate response is estimated at about 10^5 cycles per second in the case of rapidly varying strains. There is a gradual zero shift with repetition of dynamic strain.

A serious problem frequently encountered is that of protecting the gauge from moisture, since, due to the high gauge resistance, very good insulation is essential for avoiding error due to leakage. Nevertheless, by covering the gauge with a special wax, it can be made to function successfully even under water. In this connexion, Mr. H. Bull, of S.R.E. Admiralty, mentioned instances of gauges applied to ships' hulls for the study of stresses in the neighbourhood of welds. The plate on which the gauge is already fixed is heated to 125° C., using infra-red lamps and, immediately on removing those, a protective wax is

* A good description of the principles of this gauge was given by Dr A. C. Redshaw before the Royal Aeronautical Society on March 28, 1946. Many papers on methods of application have been published in the *Proceedings of the Society for Experimental Stress Analysis*, U.S.A

poured over the gauge, thus excluding all moisture. Gauges so prepared have worked well in sea-water over a long period. Other speakers discussed the effect of thickness of adhesive on the steady temperature difference between gauge and test piece. Dr. A. C. Redshaw reported favourably on a new type of woven gauge in which the wires are interrupted and carry end connexions at regular intervals for ensuring uniformity. These gauges, in which the wire is interwoven with artificial silk, he had found to give remarkable consistency.

Mr. E. Jones, questioned as to the adaptability of the normal type gauge to curved surfaces, said that they can be used on curvatures down to $\frac{1}{2}$-in. radius. The usual gauge-length for aircraft structures is $\frac{1}{2}$-in. or larger, but gauges no longer than $\frac{1}{16}$ in. have been successfully employed for special jobs.

Strain gauges are conveniently adapted for many different types of measuring instrument. The exhibits shown by the Royal Aircraft Establishment, Farnborough, included dynamometers, manometers, micrometers, and accelerometers which record by this means. It was pointed out that the ring type of dynamometer affords perfect temperature compensation, as the compression gauges mounted opposite those in tension eliminate the necessity for dummy gauges. Dr. E. Orowan (Cavendish Laboratory) gave a brief description of a cylindrical steel pin, about 2 in. in diameter, forming part of a rolling mill bearing, which had been machined away in four places for longitudinal gauges, the compensating gauges being in a circumferential groove. This device is being used for measuring the forces and torques during rolling operations. As the economics of steel mill operation demand that the rate of rolling should be as high as possible without overstressing the mill, an accurate knowledge of these forces is of great importance.

Technicians concerned with the measurement of rapidly changing stress have not been slow in exploiting the great possibilities of the strain-gauge, with its ease of installation, lightness, freedom from inertia effect and robustness as compared with mechanical tensometers. By transforming strain directly to change of electrical resistance, all mechanical parts can be eliminated, and the gauge signal is readily recorded, either by a high-frequency galvanometer or, after suitable amplification, on a cathode-ray oscillograph.

Equipment of this kind is already in use for studying the fluctuations of strain in aircraft propeller blades, strains due to gusts, manœuvres, and landing in aircraft, for industrial machinery of widely varying types, the performance of fatigue testing machines, and so on. The choice of amplifier depends on the particular application, and frequency modulation is often employed. The L.M S. Research Laboratories reported at the conference that, using a high-frequency carrier, they can record at 100 yd. from the gauge.

Another interesting form of strain gauge, namely, the acoustic strain gauge, was discussed by Mr. Bull, of S.R.E. Admiralty. These gauges were first tried in Germany. In Great Britain, the Steel Structures Research Committee was the first to use them. The present form of gauge, due to the Building Research Station, has given excellent results in the hands of the Admiralty (S.R.E.) Shipwelding Party and on steel bridges. Mr. Bull said that with acoustic gauges the return to zero is much better than with resistance gauges. The gauge consists of a stretched wire, the natural frequency of which varies with the strain. The latter is measured by the pitch of the note given out when the wire is excited. This is obtained by the beat method, using a master gauge having a micrometer tensioning head. Alternatively, a cathode-ray tube may be used, in which the two oscillations are connected on the x- and y-axes and brought into step. Aural matching, though quite feasible, is rather trying to the nerves. Owing to the necessity for long-distance recording, an elaborate system of post-office type selection with satellite points and master control was adopted. Six hundred of these gauges could then be recorded in the space of two hours. Though not nearly as fast as some resistance-gauge systems, this rate of recording is certainly a great feat. In the application of this method to welding investigations in ships' plates, one of the practical drawbacks is the magnitude of the temperature stresses which occur in day-time. Most of the work, therefore, must be done in early morning or late evening.

Mr. R. S. Jarratt, of the Building Research Station, described the application of acoustic strain gauges to the measurement of strains in bridge girders. He suggested that the gauge signal, being of audible frequency, could, if required, be transmitted by radio, so reducing very much the amount of screened cable required for distant recording. Using screened cable, the Building Research Station has recorded at a distance of 600 ft.

The morning session on July 12 was devoted to photo-elasticity. The present writer contributed a paper entitled "A Review of some Recent Developments in Photo-elasticity", a summary of which follows:

Advances in equipment and materials have been mainly due to the replacement of Nicol prisms by 'Polaroid' and to the use of synthetic resins having high stress-optical coefficients The glyptal 'bakelite', known as *BT* 61–893, has excellent properties, but is in very short supply. Glass-clear phenol-formaldehyde resin can be more readily obtained and has a high stress-optical sensitivity.

Improvements in the technique of preparing models, due mainly to Frocht, have made possible the accurate observation of boundary stresses in plane models.

Three separate methods have been employed for solving 3-dimensional problems—the 'freezing', the 'scattered light', and the 'composite model' methods. The most adaptable of these is the 'freezing' method, for which either 'Bakelite' *BT* 61–893 or phenol-formaldehyde resin (for example, 'Catalin' 800 glass clear) can be used. When heated the material reaches a softened condition in which Hooke's Law is accurately obeyed, but the Young's modulus is of a much lower order than at room temperature. The stress-optic law has been shown to hold accurately in this condition. A three-dimensional model is heated to the softened condition (to about 110° C. in the case of *BT* 61–893 and about 80° C. in the case of *p–f* resin) and the load applied. After maintaining the temperature for some 15–30 minutes to allow the strain to reach a steady condition, the model is cooled to room temperature. The model thus 'sets' or 'freezes' in the strained condition, and on removal of the load, loses only a small proportion of its strain and birefringence. If a plane slice is cut out of the model (using fine cuts and a cooling fluid), it will show the fringe pattern corresponding to the stresses existing in the complete model.

As shown by Hiltscher (1938) the 'frozen' birefringence can be measured by examining a slice (3 mm.

thickness) in convergent light, using a polarizing microscope in exactly the same manner as for crystals. This method will give, for any point, in a slice taken in any direction in the model, the orientation of the three principal stresses, their order of magnitude, and the value of the three principal shear stresses. The chief drawback of the 'freezing' method generally is the production of edge stress in heating, and research is needed into methods for preventing its occurrence

In the 'scattered light' method, due to Weller, a narrow collimated beam of polarized light is passed through the model, and fringes in the interior of the model can be seen by viewing at an angle to the direction of the beam, owing to the effect of scattering.

The 'composite model' method, originally suggested by Favre, as its name implies, uses a model built up of two materials (having the same elastic modulus). An inner, birefringent section is encased in an outer part which has no stress-birefringence, so that the stresses in the middle part only of the 'sandwich' are shown.

For separation of the principal stresses at interior points on a plane model it is necessary, by some means or other, to determine $P + Q$, the *sum* of the principal stresses. The isochromatic order, shown by the fringe pattern, gives $P - Q$ only. The classical method for finding $P + Q$ is that of the lateral extensometer as designed by Coker. Three alternative methods were reviewed by the present writer, namely the 'Four Point Influence Method'—a process of relaxation—the 'Method of Oblique Incidence' (as used by Drucker), and the individual measurement of the principal stresses by means of an interferometer.

Some instances of the application of photo-elasticity to special problems were discussed by the author. Perhaps the most valuable photo-elastic work of all has been the determination of stress concentration factors at holes, notches, and fillets, of great importance where components are subjected to repeated or reversed loading.

Mr. H. M. Ross (Kodak, Ltd.) followed with a colour film illustrating stress in a rail and chair under fluctuating loads, and a remarkable slide showing, in colour, the stress waves resulting from the impact of a hammer on a nail embedded in a block. He also described techniques for photographing fringes.

Next, Dr. E. Orowan described briefly an ingenious combination of photo-elastic and photo-electric technique for showing the fluctuations in load in a rolling mill. The skill with which Dr. Orowan applies scientific technique in such unpromising surroundings deserves great admiration.

The discussion on photo-elasticity centred mainly around the behaviour of materials during the 'freezing' process. Photo-elastic observations represent purely elastic conditions of stress, and, for singly connected bodies, the stress distribution is then exactly as in the prototype, being independent of the elastic constants

On the important question of how exact the collimation should be, Mr. Heywood stated that the fringe patterns shown in an exhibit of pieces of mechanism in 'Bakelite' prepared by Rolls Royce had been made without a collimating lens. There was not the least blurring of the fringes in these photographs. As the interest in any given model usually centres around a small portion of the boundary, indistinctness due to imperfect collimation can be avoided by bringing this portion into the centre of the field.

Several speakers emphasized the need for a full exploration of the possibilities for improving the materials at present available, and directed attention to the difficulty in obtaining photo-elastic glyptal resin in Great Britain. The need for closer contact between those especially interested in photo-elasticity was recognized, and the possibility of forming a photo-elastic group, or society, in the near future, to create an opportunity for workers in this field to meet and exchange views on questions of materials and technique was discussed [see *Nature*, October 5, p. 478].

The afternoon session on July 12 must be passed over very briefly. Mr. D. E Thomas (Armament Research Dept.) and other speakers described the application of X-ray technique to the measurement of strain in metals. To avoid surface stress due to machining, it is necessary to remove the surface layer by etching to a depth of 0 01 in. Members of the Admiralty Staff further described portable X-ray apparatus for taking strain measurements on welded ships' plates, etc. It was pointed out that the X-ray method is the only non-destructive way of determining surface residual stresses.

Mr. C. E. Phillips (National Physical Laboratory) described different mechanical-optical extensometers, the variety of which appears to be almost infinite. He said that each different type of problem calls for a special design. He also made the point that *stress* is not a measurable quantity. We strain a material, and this induces a stress in it; but it is *strain* which must always be measured. Even in applied photo-elasticity, one feels, with all due respect to Coker and Filon, that it would be more correct to speak of a 'strain-optical' than of a 'stress-optical' effect. Nevertheless, in many materials, when they are stressed beyond the limit of proportionality, the birefringence follows the *stress* more closely than the *strain*. In such a question, the microscopic heterogeneity of the material no doubt plays an important part.

Remembering Griffith's remarkable results on the strength of glass fibres, one is forced to the conclusion that the *strength* of a material in the mass is entirely a statistical effect. Similarly, examination of single crystals of ferrite shows widely different maximum and minimum values of Young's modulus, and these values differ from that for an aggregate of crystals.

It is clear that those quantities which form the entire basis of the engineer's calculations—strength, elastic modulus and stress—are, after all, statistical quantities applicable only to material in the mass. It is indeed fortunate for the engineer that, in respect of these quantities, his materials exhibit such high homogeneity and isotropy.

There are still many questions to be resolved regarding the transition from X-ray results to engineering quantities. In the application of these methods (as in that of many others) to industrial problems, one must guard against the tendency—all too common—to regard them as a machine which must automatically give the right answer. It is not the tool itself, but its intelligent and skilful application, which produces reliable results.

The exchange of experiences and information afforded by a conference such as that held at Manchester is one of the best ways of acquiring mastery in the application of modern methods. The Manchester Branch of the Institute of Physics and, in particular, Dr. F. A. Vick, are to be congratulated on the success which attended their efforts.

W. A. P. FISHER

ANALYSIS OF THE ELECTRICAL RESPONSE OF THE HUMAN CORTEX TO PHOTIC STIMULATION

By W. GREY WALTER, V. J. DOVEY and H. SHIPTON

Burden Neurological Institute, Bristol

IN 1934, Adrian and Matthews[1] showed that rhythmic electrical potential changes could be recorded from the occiput in man when the subject's eyes were illuminated by a bright flickering light. These electrical rhythms were shown to be generated by the visual projection areas of the brain, and their relation to the spontaneous 'alpha rhythms' of the human electro-encephalogram, which they sometimes resemble, has often been discussed.

Both on theoretical grounds and from the observations reported below, it seems likely that the resemblance between the rhythms evoked by photic stimulation and those occurring spontaneously in the resting subject is superficial, though there is a subtle and complex relationship between them.

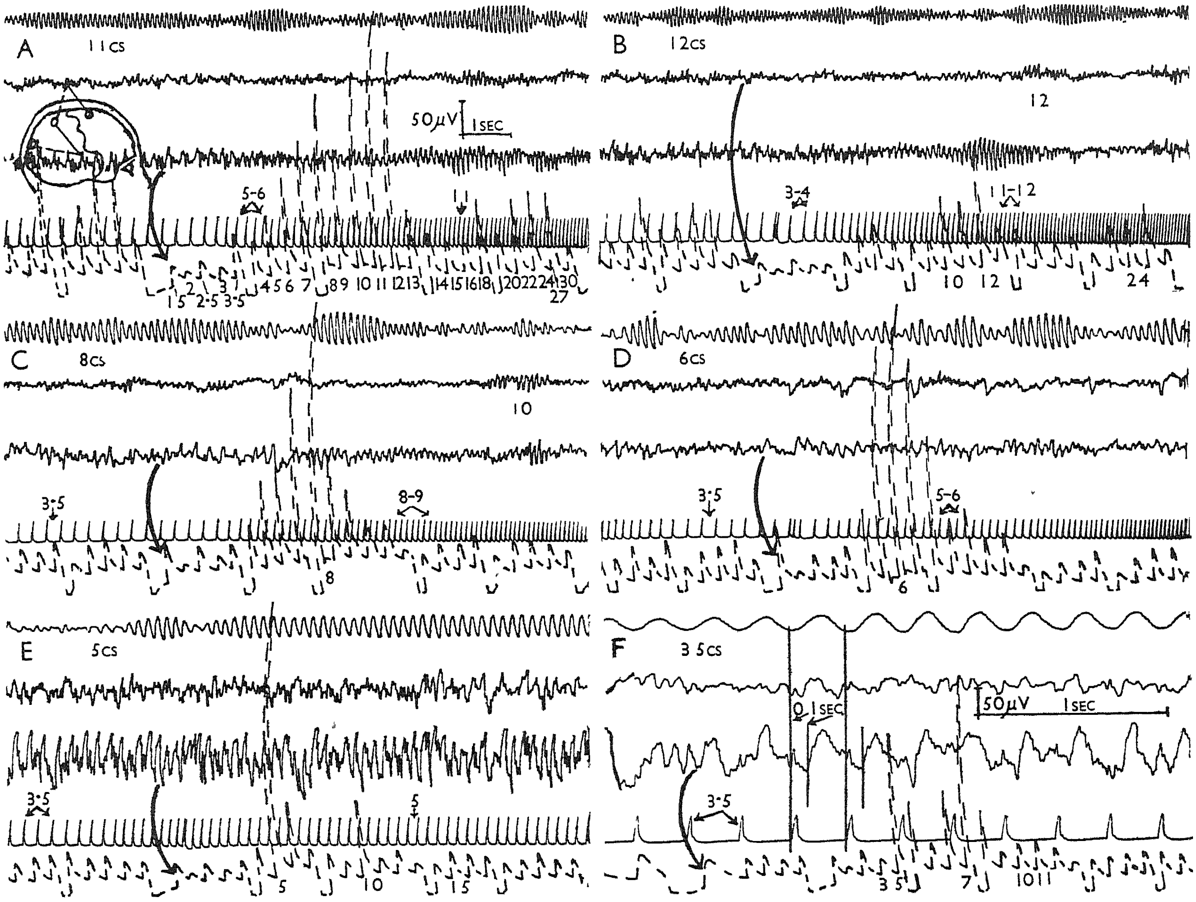
There are two technical difficulties in studying the evoked potentials. First, it is desirable to provide a bright source of light which can be made to flicker at frequencies between one and a hundred flashes per second without variation in intensity or duration of each flash. Such a source is now available in the form of the 'high power stroboscope' (for example, the instrument manufactured by Scophony, Ltd.) in which the duration of the flash is of the order of 10 µsec. The second difficulty is that the evoked potential changes, like the spontaneous ones, are usually too complex to be interpreted by the unaided eye[2]. The combination of rhythmic stimulation with frequency analysis of the resulting records provides a sensitive method of studying central nervous activity. Its value in animal experiments has already been demonstrated by the workers in the Brain Institute in Moscow under the direction of Sarkisov, using very tedious mathematical analyses[3,4]. The system of continuous automatic analysis described by Walter[5,6] and Baldock and Walter[7] considerably extends the scope of interpretations. With this equipment the frequency analysis of the primary trace is automatically inscribed as a band spectrum on the same record every ten seconds in a contrasting colour (shown dotted in the records reproduced). The frequencies covered are from 1·5 to 30 c/s. Using these two electronic accessories, together with a four-channel ink-recording electro-encephalograph, the responses evoked by flickering light in a number of normal subjects and a few clinically abnormal ones have been studied. The results may be summarized as follows.

(1) There is very great variation between individuals in respect of: (*a*) amplitude of response, (*b*) selectivity of the response at different frequencies, (*c*) effect of other external stimuli and mental activity, and (*d*) constancy from time to time. In some subjects scarcely any rhythmic activity can be seen in the primary traces at any frequency, while in others the evoked potentials are of the order of 50 µV. up to frequencies of 15–20 f/s. In those subjects with a well-marked response there is usually a 'resonance' frequency at which the response is both larger and less complex than at other frequencies. This frequency is not necessarily that of the dominant resting alpha rhythm, but it is often related to some component of the resting electro-encephalogram revealed by analysis. Thus in the subject of Fig. *A*, the resting analysis showed no consistent alpha components; but the evoked response resonates quite sharply at 11 flashes per sec. (f/s) in the occipital pole, and at 12 f/s in the parieto-occipital region (*B*). In this subject, who is a marked visualist, the evoked response was larger with the eyes shut (or with a diffusing screen within the near point) than with the eyes open. Another subject (Fig. *C*) has a prominent resting alpha rhythm with two components at 8 and 10 c/s. The evoked rhythms show a less-distinct resonance at 8 c/s in the occipital pole and at 10 c/s in the parieto-occipital areas. In this subject, who uses mainly auditory and kinæsthetic imagery, the responses were larger with the eyes open, and the 8 c/s resonance point was associated with vivid subjective kinæsthetic sensations. In a third subject, the resting analysis shows components at 6, 8 and 10 c/s, while the evoked resonance was at 6 f/s in the occipital pole on this occasion. At other times this subject showed a marked resonance at 3·5 f/s in the parietal region, but never at 8 or 10 f/s.

In all the subjects so far studied the evoked response, at flicker rates from 7 to 14 c/s, like the resting alpha rhythm, was diminished to some extent in amplitude and regularity by mental activity involving visual imagery, but the relative effectiveness of various types of task varied greatly from subject to subject. In subjects with a pronounced response at frequencies below 6 c/s, the effect of mental activity was less clear. With practice, most subjects were able to recognize the resonant condition by a subjective change in sensation. When the resonant response is in a brain area other than the visual projection centres, the subjective experience is usually somatic, kinæsthetic or abstract.

(2) In children below the age of 12–14 years (and in a few young adults) the responses were relatively large (of the order of 100 µV.) at the lowest frequencies; but insignificant above 6–7 f/s (Fig. *E*). In this child, aged ten, there was a prominent resting alpha rhythm at 10 c/s but no tendency to a response resonance at this frequency. A prominent feature in most records of this type is the downward (negative) 'spike' following the slower primary positive component of the response. The time relations of the latency and duration of the response are shown in Fig. *F* taken from the same child at a higher recording speed. In such records the analysis shows a large second harmonic content, associated with the extreme asymmetry of the 'saw-tooth' wave-form.

(3) In all subjects, analysis of the response showed considerable harmonic content, particularly at flicker rates from 1 to 7 f/s. In some records components up to the 6th harmonic can be detected in the spectrum, the 2nd, 3rd and 5th being the most usual. These harmonics might be attributed merely to the inherent complexity of the nervous processes responsible for the wave-form, but phase-discriminating topographic analysis often permits identification of these harmonic components as separate entities apart from the fundamental evoked rhythm in areas of the brain other than the visual projection areas.



ANALYSED ELECTRO-ENCEPHALOGRAMS TAKEN DURING EXPOSURE TO FLICKERING LIGHT IN EACH RECORD THE TOP TRACE SHOWS THE RESPONSE AT A SELECTED FREQUENCY AS INDICATED THE SECOND AND THIRD TRACES ARE THE ELECTRO-ENCEPHALOGRAMS FROM THE REGIONS INDICATED BY THE HEAD DIAGRAM. THE FOURTH TRACE SHOWS THE FLASHES OF LIGHT AS SEEN BY A PHOTO-ELECTRIC CELL BETWEEN THE SUBJECT'S EYES THE FIFTH TRACE (DOTTED) IS THE FREQUENCY SPECTRUM OF THE RECORD INDICATED BY THE ARROW THE AMPLIFICATION AND TIME-SCALE FOR *A*, *B*, *C*, *D*, *E* ARE GIVEN IN *A* THE ANALYSER SCALE IS ADJUSTED TO A CONVENIENT SIZE FOR EACH RECORD

The amplitude and distribution of the various harmonics is particularly sensitive to the influence of other stimuli. Sub-harmonics in the band from 4 to 7 c/s are prominent in some subjects who show these rhythms in the resting records, when the flicker is at a frequency from 8 to 14 f/s. Similar sub-harmonics are seen in certain conditions in other subjects, when the flicker frequency is rapidly varied between about 10 and 15 f/s. The latter effect is accompanied by unpleasant 'swimming' sensations.

(4) By employing an electronic trigger circuit the flashes can be synchronized either with the unfiltered brain rhythms or with any selected component of them derived from one of the resonant circuits of the automatic analyser. With the first arrangement any tendency to resonance can be clearly demonstrated, since each flash evokes a response which in turn produces a flash, and so on; the system (lamp-visual cortex—amplifier—trigger—lamp) settles down to oscillate at a frequency depending upon the latency of the cortical response and the phase of the response wave-form used to actuate the trigger. A number of modes of oscillation can be observed depending upon the details of the experimental conditions, which are too complex to summarize.

The method may have clinical as well as physiological application. For example, in an epileptic patient whose resting E.E.G. analysis showed a large component at 8 c/s, together with a number of other frequencies, synchronization of the flash alternately with the components at 16 and 8 c/s regularly evoked a brief larval seizure discharge of the characteristic wave and spike type, although the patient was under the influence of large doses of anticonvulsant drugs and was almost free from spontaneous attacks. This observation appears to support the hypothesis, based on study of analysed epileptic records, that certain types of seizure are due to exact synchronization of cerebral rhythms previously slightly out of step.

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OBITUARIES

Sir James Jeans, O.M., F.R.S.

SIR JAMES JEANS, the celebrated mathematician and astronomer, died on September 16, at the age of sixty-nine. Expositor of science, philosopher, musician, he was above all a powerful and prolific applied mathematician, who made fundamental advances in the theory of gases and the physics of the atom, of the photon and of quanta on one hand, and the physics of the stars and nebulæ, their structure and evolution, on the other. As life went on, he became more and more devoted to astronomy, cosmogony and allied fields; but he interpreted those disciplines in the widest sense, able to combine simultaneously the most minute detail with the grandest generality. No one can read his treatises, even his text-books, without experiencing an undercurrent of growing excitement as solution succeeds to formulated problem; the reader feels himself in the presence of a master-mind. Indeed, his name will always be linked with those masters in the true Newtonian tradition—with Roche, Poincaré, Schwarzschild, Sir George Darwin and Liapounoff, who formulated, grasped the cosmic importance of, and by degrees solved, the question of the stability of equilibrium configurations of rotating masses of fluid. Of these, Jeans may be most fitly compared with Poincaré; both were attracted by, and both took part in the birth of, modern atomic physics and the quantum theory; both attached great importance to thermodynamics; both made some of their most characteristic contributions in the theory of rotating fluids and cosmogonic hypotheses; both were possessed of a fine mathematical style which banished dullness even from apparently arid calculations; and both wrote extensively on the philosophical aspects of science.

James Hopwood Jeans was born at Southport in 1877. He was educated at Merchant Taylors' School and Trinity College, Cambridge, from which he graduated as second wrangler in the Mathematical Tripos of 1898; he became a fellow of Trinity in 1901. After lecturing for a short while at Cambridge, he was appointed in 1905 to a chair of applied mathematics at Princeton, which he occupied until 1909. He then returned to Cambridge as Stokes Lecturer. He soon gave up formal teaching for research, and obtained in 1917 the Adams Prize for his superb essay, "Problems of Cosmogony and Stellar Dynamics", published in 1919. He had previously published (in 1914) his "Report on Radiation and the Quantum Theory" for the Physical Society. He was elected a fellow of the Royal Society in 1906, at the early age of twenty-eight, was awarded a Royal Medal in 1919, and served as secretary of the Royal Society during 1919–29, a period which was marked by a great revival of interest and quality in that Society's *Proceedings*. He was created a knight in 1928, and was awarded the Order of Merit in 1939. Latterly he had held a professorship of astronomy at the Royal Institution. He was president of the Royal Astronomical Society during 1925–27, and had been awarded its Gold Medal in 1922. He had the notable distinction of being made a research associate of Mount Wilson Observatory in 1923. Several universities, at home and abroad, honoured him with their doctorates.

These distinctions were merely the outward adornments of a life devoted to pure science, without which physics and astronomy would scarcely be the same to-day. He began his researches by following the paths trodden by Sir George Darwin, whom he always held in high honour: the George Darwin Lecture of the Royal Astronomical Society was founded out of a gift made by Jeans. But Jeans soon turned his attention to the theory of radiation, and in 1905 he gave the *coup de grâce* to the classical theory by demonstrating in detail the classical formula for the partition of radiant energy in an enclosure, a formula put forward by Lord Rayleigh in 1900. This has since been known as the Rayleigh–Jeans law. Jeans embodied these and many other original calculations in statistical mechanics in his treatise "The Dynamical Theory of Gases", which has been used by generation after generation of students.

But Jeans' main love was cosmogony. In "Problems of Cosmogony and Stellar Dynamics" he devoted his splendid mathematical gifts to a full-scale assault on the question of the stability of the forms of equilibrium of rotating masses. It had long been known that a rotating incompressible mass under its own gravitation assumed for small angular velocities the form of a spheroid—the series is known as Maclaurin's spheroids—and that for increasing angular velocity stability passed at a certain stage to ellipsoids with three unequal axes—known as Jacobi's ellipsoids. Poincaré discovered that these ellipsoids, when there was no constraint compelling them to remain ellipsoids, developed a furrow round the long axis, and so became what are known as 'pear-shaped figures', but he did not ascertain their stability. Darwin, in 1902, convinced himself that they were in fact stable, but Liapounoff in 1905, in a memoir published at St. Petersburg, announced the opposite result. The importance of a decision between these conflicting results lay in the application to the origin of double stars by fission: if, as Darwin believed, the pear-shaped figure was stable, then this figure could evolve quasi-statically into a double star as the furrow deepened; but if, with Liapounoff, we consider the pear-shaped figure as unstable, then, when the stability of the Jacobian series ends, a cataclysm will result. Jeans investigated the potential of what he called a 'distorted ellipsoid' by a new analytical method, abandoning the method of ellipsoidal harmonics previously used. This enabled him to locate an error in Darwin's calculations, and to confirm Liapounoff.

This investigation is conducted in masterly fashion in the Adams Prize essay. But Jeans did not confine himself to the abstract rotational problem: after summarizing the fundamental paper by Poincaré in the *Acta Mathematica* of 1885, with its treatment of linear series and points of bifurcation, he analysed in turn the rotational problem, the tidal problem and the double star problem, for incompressible and compressible masses, and considered also Roche's model; he gave an account of Roche's limit for a satellite, and traced the cataclysmic process by which a stable double-star configuration might evolve from the instability of pear-shaped configurations. His plan was to work out unsparingly the main mathematical problems, and then, without any putting forward of a preconceived theory, to investigate the bearings of these abstract solutions on the possible origins of the various types of celestial body. He concluded that spiral nebulæ might be formed by the ejection of matter from the sharp lenticular edge of a rotating compressible mass, at antipodal points determined by the net tidal force due to the rest of the universe;

that condensations of stellar magnitude would be formed in the arms (the spiral form of which, however, he could not account for); that some of these might eventually break up by fission into close double stars, but that wide doubles were probably formed by a capture process; that nothing resembling a solar system could be produced by rotation alone, and that the hypothesis of Kant and Laplace in at least its original form was untenable; that, as an alternative, the hypothesis of disruption by a tidal encounter fitted many of the facts; but that if this were the actual origin of the solar system, then planetary systems similar to it must be very rare in Nature, so rare that possibly ours is the only one.

It is the usual fate of cosmogonic theories not to survive, and many of Jeans' conclusions, especially since the discovery of the expansion of the universe, are already in course of revision. But "Problems of Cosmogony" was grand stuff from beginning to end. We saw a master thinker and executant at work with his materials. He set a standard of perfection of scholarship in a field often marred in others' hands by propaganda; the work was marked by power, depth and originality of a high order.

His later volume, "Astronomy and Cosmogony", more comprehensive and more ambitious, was less successful. Besides reconsidering and enlarging much of the Adams Prize essay, it aimed at giving an account of the internal constitution of the stars on rather different lines from the work of Eddington. Some of Jeans' mathematics in this volume is far from clear. His conclusions that the different types of stars—giants, main sequence stars and white dwarfs—correspond to the successive removals of the M, L and K rings of electrons from atoms by ionization are hard to accept. But his other conclusions, that the stars in general have 'liquid', not gaseous, cores, and consist of elements of atomic number 95 or so, are perhaps more acceptable to-day than when they were published There is, however, scarcely a page of even this second treatise which is not rich in fascinating suggestion and inspiring possibility; on each page we see a master mind confronting itself with the grandest problems, of formidable difficulty, posing them, simplifying them, and making some progress with even the most intractable.

Jeans influenced astronomical investigation in many other domains besides those mentioned above. He first gave the name 'equation of transfer' to the equation which traces the intensity of a pencil of radiation through an absorbing and emitting medium, an equation in daily use in investigations on stellar atmospheres; and he first directed attention to the phenomenon of radiative viscosity. He made the suggestion that the source of stellar energy might be the mutual annihilation of protons and electrons; and he, more than anyone, stood for the belief that the universe is doomed to a 'heat-death'. He did not form a school of research in the ordinary sense; but everyone who is interested in the beginnings, evolutions and endings of the various members of our universe is in a sense his pupil. We have lost a great leader.

Jeans had a brisk business-like manner in ordinary conversation, not at all suggesting the deep academic thinker that he was; but it developed in the lecture theatre into a winning persuasiveness. He was extremely modest, a most courteous correspondent and a scrupulously fair opponent in a controversy; and he gave freely of his friendship to many. He was twice married. E. A. MILNE

Prof. Otto Hönigschmid

BY his untimely death during October 1945, a tragic victim of war conditions, chemical science has lost in Prof. Otto Honigschmid one of its leading workers in the field of inorganic chemistry. His name will always be remembered in chemical circles as the outstanding authority in Europe on the chemical atomic weights, and for the active school of research he built up at Munich after his appointment there in 1922 as professor ordinarius.

Born in Horovitz in Bohemia in 1878, he graduated in the German University of Prague and studied as a research student under Moissan in Paris (1909–10) and later with Th. W. Richards at Cambridge, Mass., where he learnt and applied the methods developed at Harvard to the determination of the atomic weight of calcium

At that period, cumulative evidence from various sources, notably from the atomic weight laboratory at Harvard and from Guye's physical chemistry school at Geneva, had shown that Stas' classical values for the fundamental atomic weight ratios were affected by significant and hitherto unsuspected errors. Stas' value for silver, the standard to which all his other values were referred, came under suspicion, and his value for nitrogen had been shown by Guye and others to be too great by as much as one part in four hundred. Since at that time the measurement of stoichiometric ratios afforded the only means of finding atomic weights with accuracy, density methods being regarded as approximate only, a general revision became imperative. This had already been made for many of the common elements by Richards and his co-workers, who had developed to a high degree the very exacting preparative and analytical technique essential in this field of work. Much, however, remained to be done, and Honigschmid on his return to Europe dedicated his energies to researches of this nature.

In Vienna, Honigschmid made, at this period, what was then claimed to be the first really accurate determination of the atomic weight of radium, using as the starting material preparations containing 840 mgm. of the pure element. Twenty-two years later, this work was repeated in Munich, using the much larger quantity of 3 gm of element, put at his disposal by the Union Minière du Haut Katanga, of Brussels, and which was initially 98 83 per cent pure. This large quantity enabled a very effective fractional crystallization to be made without reducing unduly the quantity of the final pure material. The atomic weight found was 226·05, the present International value; which was only 0·08 unit greater than the earlier one.

Hönigschmid's most active period of research began after his promotion from the directorship of the inorganic and analytical laboratories at the Technische Hochschule, Prague, to the University of Munich, where he founded a laboratory devoted entirely to the determination of atomic weights by analytical methods.

From this laboratory, year after year, appeared a stream of papers embodying improved techniques for the preparation of chemically pure substances, and for their analysis, and containing fresh data of the highest accuracy on atomic weight ratios. Up to 1938 he and his co-workers had re-determined the atomic weights of upwards of forty elements, which led to numerous revisions in accepted values.

Hönigschmid was the first to determine the atomic weights of hafnium and rhenium, and his careful work on radium, thorium, uranium and ionium as well as on the radiogenic leads contributed in no small degree to the body of direct chemical evidence which supports Rutherford and Soddy's theory of radioactive disintegration.

To the Munich school belongs the chief credit of establishing on a firm basis that important sub-standard, the atomic weight of silver, with sufficient accuracy to enable it to be used as a reference standard for the halides of elements of low atomic weight such as lithium and sodium. Hönigschmid directed attention to the small difference between the atomic weight of silver derived from the synthesis of silver nitrate made in 1907 by Richards and Forbes and that from the lithium perchlorate/lithium chloride/silver ratios measured three years later by Richards and Willard. The former, assuming nitrogen to be 14·008, gave for silver 107 879, whereas the latter yielded 107 871—a small difference indeed, but one which would cause a much greater uncertainty in the atomic values for light elements. To investigate this, Hönigschmid, Zintl and Thilo re-determined the nitrate ratios by the reduction in hydrogen of specially purified silver nitrate, and by this analysis obtained precisely the same value, to 1 part in 150,000, for the ratio silver nitrate/silver as that found by synthesis eighteen years earlier at Harvard.

This research, published in 1927, was followed in 1929 by the work of Hönigschmid and Sachtleben in which barium perchlorate was used to link silver to oxygen. These two researches led to closely concordant results which confirmed the higher of the two values for silver and went far to settle the discrepancy. Subsequent work on silver has supported Hönigschmid's conclusion, and the uncertainty now in this standard probably does not exceed two units in the third place of decimals.

The development of the mass spectrograph by Aston, and the discovery that many chemical elements were mixtures, gave a new direction and impetus to chemical work. Chemists were concerned to know how much reliance could be placed on the new physical method and whether the very significant differences between many of the chemical and physical values were to be explained by chemical or by physical errors. On both sides of the Atlantic, in the two chief schools for this type of work, at Harvard and at Munich, numerous re-determinations were undertaken, with the result that in most cases the mass spectrograph values were found the more reliable and pointed the way to the elimination of chemical errors. In these activities Hönigschmid and his pupils played an important part. For example, his work on niobium and tantalum is outstanding, as also is his work on the atomic weight of phosphorus. In all three cases he proved that the accepted chemical values were markedly too high, and that when really pure halides, or oxyhalide in the case of phosphorus, were used a close concordance with the mass spectrograph was obtained.

In a few instances, however, errors were discovered in the mass spectrograph values, and chemical revision even with extreme elaboration failed to bring the two sets of data into accord. Such was the case with cadmium and tellurium, which when revised chemically by Hönigschmid paved the way to the discovery of new isotopes of tellurium and a modification of the abundance ratios for cadmium. Another example is that of neodymium, the chemical value of which when revised by Hönigschmid and Wittner was found in agreement with the earlier value of Baxter and Chapin, and nearly 0·8 unit higher than Aston's value, which has now been shown by Mattauch to have been based on an isotopic constitution affected by small errors.

Mention should be made, too, of Hönigschmid's application of precise analytical methods to detect and measure the degree of isotopic separation achieved by evaporation at low pressure, in the pioneer experiments of Bronsted and Hevesy on mercury and on lead chloride and by Hevesy alone on potassium. In those for mercury and potassium the separation was small but definitely detectable Much later, he tested the isotopic hydrogen chlorides obtained by Clusius and Dickel in their thermal diffusion apparatus, and confirmed beyond doubt that the separation was practically 100 per cent.

During the earlier part of the War, Hönigschmid appears to have continued his atomic weight work for, in 1941, he published papers on zinc, samarium, and yttrium. Later work from his laboratory has not been reported.

Finally, the services rendered to the German Atomic Weight Commission by Hönigschmid, who was chairman during 1920–30, must be noted. The eleven yearly reports and reviews of the progress of research with the annual table of the most trustworthy atomic weight values came mainly from his pen. In 1930, when the Atomic Weight Committee of the International Union of Chemistry came into being, Hönigschmid was the obvious choice for the German representative. Under the chairmanship of Prof. G. P. Baxter, eleven international reports have been issued since then, and although from time to time there has been a change in membership, Otto Hönigschmid and his opposite number, G. P. Baxter, the leaders of the two chief schools of atomic weight research in Europe and America, have invariably been re-elected.

Enough has been said in this notice to indicate the great part played by Otto Hönigschmid in analytical and atomic weight research. It is a matter of general regret that work like his, of a truly international character, should have been abruptly terminated before his energies were exhausted.

R. WHYTLAW-GRAY

Prof. I. Mościcki

PROF. IGNACY MOŚCICKI, former President of Poland and a distinguished chemist, died on October 2 at Versoix, Geneva, in his seventy-ninth year.

Born at Mierzanow, then in Russia, Mościcki was educated locally and at Riga, but his revolutionary views necessitated his leaving Russia. For five years he stayed in England, spending some time at Finsbury Technical College. Then he went to the University of Fribourg as assistant to Prof. Kuwalski, under whose influence he became interested in the applications of science and made a careful study of the methods for the fixation of nitrogen. He invented new processes that proved successful, and in 1913 he was appointed professor of electrochemistry at Lwów (then in Austria).

After the liberation of Poland, Mościcki became head of the chemical works at Chorzów and Mościce (named in his honour). He succeeded in establishing the Polish chemical industry on a firm basis, and when Marshal Pilsudski rose to power in 1926, Prof. Mościcki was elected President of the Polish Republic. He was now able to use his influence for the furtherance of the educational and scientific programmes connected with the various Polish universities and cultural bodies. Re-elected President in 1933, he was head of the State when Germany invaded Poland in 1939; within a month Mościcki relinquished office, escaped to Rumania and then succeeded in reaching Switzerland. In view of his earlier sojourn (lasting sixteen years) in that country, he was granted Swiss citizenship, and he was thus able to spend his last years in quiet retirement.

We regret to announce the following deaths:

Prof. E. H. Lamb, formerly professor of civil and mechanical engineering, Queen Mary College, London, on October 12, aged sixty-eight.

Dr C. S. Myers, C.B.E., F.R.S., honorary scientific adviser to the National Institute of Industrial Psychology, on October 12, aged seventy-three.

NEWS and VIEWS

Radar Observation of the Giacobinid Meteors

Since the general occurrence of transient radio reflexions in the E region of the ionosphere, at frequencies exceeding the critical frequencies for normal or abnormal E layers, was noticed by Sir Edward Appleton and R. Naismith, in their observations during the International Polar Year, 1932–33, much work has been carried out which has shown that echoes of this type can be associated with visually observed meteors. When high-powered transmitters are used, the number of radio echoes may greatly exceed that of the visible meteors. As a result of experiments in which the directional characteristics of radar sets were utilized to investigate the aspect sensitivity of the transient echoes, Hey and Stewart have shown that the majority of the echoes at five metres wave-length must be of meteoric origin. Assuming that the most favourable aspect for reflexion is perpendicular to the meteor train and hence to the radiant, they were able to show not only that the frequency of occurrence of echoes reached a maximum at the times of the big meteor showers, but also that radiants of the streams could often be deduced and these coincided with known meteor streams. This work has been carried out in close liaison with the Slough Radio Research Station of the Department of Scientific and Industrial Research, where Sir Edward Appleton and R. Naismith have continued their studies of the transient ionospheric echoes at longer wave-lengths. The recent Giacobinid shower provided an excellent opportunity for the various investigators working in this field. J. S. Hey and his team at the Operational Research Group, Ministry of Supply, maintained a continuous watch during October 7–11 with the help of operators loaned from A.A. Command. This revealed a marked rise in meteor activity between 0100–0600 hr. on October 10, which reached a tremendous peak between 0330 and 0430 hr. G.M.T., when the echoes were too numerous to count on the cathode ray tube display. A detailed report must await analysis of the photographic recordings. Even at wave-lengths so short as $1\frac{1}{2}$ metres, a number of these echoes could be detected.

Use of Electrical Power in Great Britain

In his presidential address to the Institution of Electrical Engineers on October 3, Mr. V. Z. de Ferranti analysed the progress which has been made towards the 'all-electric' goal envisaged by his renowned father, in a paper delivered to the same institution thirty-six years ago. The latter took as his basis the 150 million tons of coal a year being used in Great Britain in 1910 and estimated that by raising the efficiency of conversion to 25 per cent the same usefulness could be achieved by the conversion of only 60 million tons into electricity. He visualized the generation of 131,400 million kWh. by means of 25 million kW. of operative plant working at a 60 per cent load factor, this plant to be concentrated in about a hundred stations spread over the country. Of these targets, the efficiency one has been exceeded in individual installations. Notwithstanding the introduction of the Grid scheme, however, progress towards the others has been slow. Thus only 24 million tons of coal a year are converted into electricity, and this is but 12 per cent of the coal now available. The electricity consumption figure is 32,000 kWh., though if recent trends are maintained the 'target' of 131,400 kWh., or about 2,850 kWh. per head of population, should be reached in 1959. It is evident, however, that with the considerably increased rise of energy consumption in one form or another, this would be far from representing the 'all-electric' condition visualized in 1910, and that much still remains to be done in the industrial and domestic fields if unnecessary waste of energy, and its several unsocial consequences, are to be avoided.

Meteors from Comet Giacobini-Zinner

Unfortunately, the bad weather conditions prevented visual observation of this shower throughout a great part of the British Isles; but observations from an aeroplane on the morning of October 10 showed that the meteors were very active—in some cases about 400 a minute. Mr. P. M. Ryves, near Ashford, Kent, observed the shower shortly before 4h. on October 10, when the sky cleared, but the peak was probably passed by that time as only three or four meteors a minute were seen. Several were as bright as Jupiter, but none much brighter was observed.

Atomic Energy Bill

Any misgivings with which scientific men have regarded the Atomic Energy Bill have been due largely to the possible effects of the restrictive clauses on scientific research. Those fears, which found ample reflexion in the debate on the second reading in the House of Commons on October 8 and at the committee stage on October 11, have been largely dispelled by the reasonable and conciliatory attitude of both the Prime Minister and the Minister of Supply. Mr. Attlee, in moving the second reading, directed special attention to Clause 11, which places restriction on the disclosure of information, and his speech indicated both full appreciation of the difficulty encountered in drafting the Bill so as to obtain the essential security without impeding scientific research, and the intention of the Government to work the restrictive clauses sensibly. Mr Attlee said that the Government had decided to define in the Bill the information which could not be communicated regarding atomic energy, and provide for excluding information about plant in use for purposes other than atomic energy if the connexion with atomic energy was not disclosed. At the committee stage, Mr. Woodburn, joint Parliamentary Secretary to the Ministry of Supply, moved a new sub-section providing that the Minister should not withhold consent to the communication of information relating to plant in general use for other purposes if he was satisfied that such information did not endanger national security, and in moving this amendment Mr. Woodburn indicated that within this strict limitation the Minister bound himself to exclude all such matters as plant for scientific research or educational work.

Mr. Wilmot, speaking on the second reading, said that the drafting of Clause 11 was the best compromise they could make, and reiterated in committee that he could not improve on the definition of his attitude in the sub-section moved by Mr. Woodburn. He was prepared to free the ordinary laboratory tools of the nuclear physicists by excluding them from the terms of the order under Clause 10, and he undertook as soon as the Bill became law to confer with physicists and other men of science affected with the view of making an order excluding those tools from the categories of plant about which communication was prohibited. Pointing out that the insertion of the words "to his knowledge" brought the words into accord with the Official Secrets Act, Mr. Wilmot emphasized that the clause gave complete freedom for the whole field unless it was associated with atomic energy plant or proposed plant. Basic scientific information was excluded, and while the clause could not be made more restrictive by the Minister, he could gradually loosen the restrictions, and Mr. Wilmot anticipated that there would be more and more exemptions and wider and wider fields outside the clause as it became possible to define more exactly the actual limits of security requirements. Even more than the words of the Prime Minister and the Minister of Supply, the whole spirit of the Government's attitude should be profoundly reassuring to the scientific world. The necessity of securing the utmost freedom for the exchange of scientific knowledge was clearly acknowledged, and also the fact that scientific progress is conditioned by the free flow and interchange of scientific opinion; and when Mr. Richard Law said that whether the Bill was effective for its purpose would depend less on what was in it than on the judgment, energy and good sense with which it was administered, Mr. Wilmot was quick to agree and to assure the House as to the spirit in which the Government intends to use its powers under the Bill

Mathematics at the Queen's University, Belfast: Dr. H. R. Pitt

Dr. H. R. Pitt, who was elected last year at the age of thirty-one to the chair of mathematics at the Queen's University of Belfast, is recognized as a leader among the younger analysts. He went to Cambridge as a scholar of Peterhouse in 1932. After taking his degree in 1935, he started research on Tauberian theorems under the direction of Prof. G. H. Hardy. Dissertations in which this was the central theme gained him a bye-fellowship at Peterhouse in 1936 and a Smith's Prize in 1937. Pitt's work was based on ideas introduced into analyses by Norbert Wiener, and the award in 1937 of the Joseph Hodges Choate Memorial Fellowship at Harvard enabled him to continue his studies under the direct influence of Wiener. This period was fruitful, and Pitt wrote further papers independently and in collaboration with Wiener and with Halperin, another member of Wiener's school. On his return from the United States, he became a lecturer at the University of Aberdeen, until his services were claimed during the War by the Air Ministry.

Application of Radio and Radar to Astronomical Research

The Operational Research Group of the Ministry of Supply has recently done much to demonstrate the potentialities of radio and radar equipments as instruments for astronomical research. An anti-aircraft equipment operating on wave-lengths around 5 metres has proved to be particularly suitable for three different investigations of astronomical interest. The receiver has been adapted for automatic recording of the intensity of the sunspot radio noise emissions discovered by Sir Edward Appleton and J. S. Hey (*Nature*, **156**, 534 (1945); **157**, 47 (1946)). The receiver has also been employed for detailed mapping of the distribution and characteristics of radio noise emissions of cosmic origin at 5 metres wave-length by J. S. Hey, S. J. Parsons and J. W. Phillips (*Nature*, **157**, 296 (1946); **158**, 234 (1946)). The complete radar equipment, with modifications originally introduced in 1944 for tracking V2, has been used by J. S. Hey and G. S. Stewart (*Nature*, **158**, 481 (1946)) for radar observation of the streaks or trains of ionization caused by the passage of meteors through the upper atmosphere. In addition to the intrinsic interest which arises in the occurrence of the above phenomena at such wave-lengths, radio and radar methods, although they cannot attain the directional precision of optical instruments, have the advantage that observations can be made in all weathers and at all times of the day.

War-time Training of Radio Personnel

The Radio Section of the Institution of Electrical Engineers held its first meeting for the current session on October 9, when Prof. Willis Jackson delivered his inaugural address as chairman of the Section. The first part of this address dealt with "The War-time Education and Training of Radio Personnel" and described the war effort, hitherto unrecorded, of the universities and technical colleges of Britain in educating and training a large number of persons for specialized radio work in the Services, Government establishments and in industry. In all, some five thousand men passed through university courses, of six terms duration, affording a substantial instruction in radio as a preliminary to their recruitment, training and employment as radio officers in the Forces, as scientific or technical officers in Service radio establishments or in the radio industry; while upwards of 70,000, including a small proportion of girls, completed courses of four months duration in technical colleges leading to their employment as 'radio' or 'wireless' mechanics, the former being concerned with radiolocation, and the latter with communication equipment. The magnitude of the latter achievement can be appreciated from the fact that it was spread over only eighty-three colleges, the remaining technical colleges providing other types of war-time training courses.

New Dielectrics in Telecommunications

IN the second part of his address, Prof. Willis Jackson referred to some recent developments in the field of dielectrics of particular interest to telecommunication engineers. Up to only a few years ago, the dielectric materials in general use were chemically and structurally very complex; but there are now available or becoming available, materials suitable for technical application which, though not strictly simple, are sufficiently uniform chemically and structurally for them to be studied scientifically, and which have the great merit that they can be prepared synthetically by controllable processes. These materials can be classified broadly as compounds of carbon, silicon and titanium respectively; and Prof. Jackson showed with the aid of diagrams the chemical structure of such materials as polythene, polyvinyl chloride, the silicones, and the titanium compounds. In addition to the technical development and improvement of such materials, the scientific side of the subject of dielectrics is attracting much interest and attention; and a considerable amount of work is also being carried out in an effort to obtain a better understanding of the physical and mechanical properties of the materials. The whole subject is one which merits the close attention of electrical, and particularly telecommunication, engineers and physicists.

University of Birmingham: Opening of Session

THE University of Birmingham, like other universities, begins its new session with a very large increase in number of undergraduates, including about 1,400 freshmen, which brings the total of students up to about 2,600 as compared with about 1,700 before the War. Many of the freshmen are ex-service men to whom, at the request of the Government, preference is to be given up to 90 per cent of places available, if necessary. This quota has been reached in civil and mechanical engineering, the former being most popular especially among ex-service men, with the consequence that many applications from schoolboys have had to be refused. In the Faculty of Medicine the competition has as usual been severe, 25 per cent of the places being allocated to women. Many applications have come from overseas, and of these preference has been given to students from British Colonies, Norway and Holland. The greatest difficulty has been to secure lodgings for students, and this has led to the appointment of a lodgings warden. The existing accommodation for teaching has been taxed beyond capacity, and recourse must be had to temporary buildings when such can be obtained and erected. The shortages of labour and materials are preventing the beginning of the great development plan for permanent building for which the money is available—during the past two years £1,000,000 has been promised by industries in the West Midlands. The Vice-Chancellor comments that for the first time the Government has learnt of the value of university graduates, so far as science is concerned, and is willing to pour in money in a way that it has never done before, so that lack of money is not now an obstacle.

University of Sheffield: Appointments

THE Council of the University of Sheffield has made the following appointments. Dr. R. S. Illingworth, to the chair in the newly opened Department of Child Health, which is to be a centre for both treatment and research; Dr. A. R. Kelsall and Dr. J. Pemberton, to be full-time lecturers in medicine; Mr. R. B. Shepherd, to be assistant lecturer in physics; Mr. W Moser, to be assistant lecturer in chemistry; Mr. J. McKenna, to be assistant lecturer in chemistry (for the session 1946–47); Mr. P. Wilkinson, to be assistant lecturer in geology; Miss V. M. Hawkins, to be assistant lecturer in metallurgy.

The Council received intimation of the following resignations · Dr. Brynmor Jones, lecturer in organic chemistry, on his appointment to the chair of chemistry at University College, Hull; Dr. I. F. S. Mackay, lecturer in experimental physiology; Dr. E. Hutchinson, assistant lecturer in chemistry; Dr. R. Halle, assistant lecturer and research assistant in the Department of Glass Technology.

Forage Resources of Latin America

THE Imperial Bureau of Pastures and Forage Crops, Aberystwyth, in association with the Technical Collaboration Branch, Office of Foreign Agricultural Relations, United States Department of Agriculture, has published the first of a series of bulletins dealing with the forage resources of Latin America ("The Forage Resources of Latin America—El Salvador", by James M. Watkins. Bulletin 35. 2*s*. 6*d*.). The economics of many of these South American countries depend almost entirely on animal products from great tracts of natural grassland. The climatic conditions of the various regions, however, are very diverse, ranging from Mexico, through the tropics to the Patagonian grazing lands of Argentina. The nature of these natural forage resources, the species which compose them and the types of management used on them are of interest and possible application in the British African Colonies and Protectorates. In El Salvador most of the best upland is devoted to coffee, which is the primary cash crop of the country, the livestock industry being concentrated chiefly along the coast. Though good pasture management is followed in some districts, the carrying capacity on the whole could be greatly increased by the better utilization of the upland regions suitable for cattle, thus leaving the coastal areas for more profitable crops. Emphasis is laid on the need for more legumes and grass-legume mixtures, *Desmodium rensoni* (barajillo) in particular appearing to be a promising plant, once sound methods have been determined for managing it and producing seed. A more liberal use of lime and fertilizers would lead to considerable improvements, and as one of the major forage problems in El Salvador is the long dry season, profitable returns could also be expected if increased attention were paid to the production of hay and silage.

Agricultural Genetics in Italy

A NEW journal, *Genetica Agraria*, has been published by the National Institute of Genetics in Rome. It will include research papers upon agriculture and genetics which were previously issued as bulletins by the research stations of Italy. Thus a wider availability and knowledge of the work of these stations can be afforded. The journal is to be issued quarterly at a cost of 300 lire per number or 900 lire per annual volume, exclusive of postage. It will be welcomed as filling a long-felt want of information regarding agricultural genetics in Italy. Vol. 1, No. 1 contains papers on such subjects as genetics of castor oil plant, genetics of lethargy of seed in and on colour of wheat, Jarovization of the potato and resistance to rust in wheat. The papers are written in Italian, but there is a summary in both Latin and English. An appendix contains abstracts of papers on genetical or plant-breeding subjects. The form and presentation of the journal are to be commended, but it might be thought desirable to obtain the aid of an English reviser for the English summaries; the summaries in the first issue do not represent adequately the Italian papers.

Naval Mining and Degaussing

A catalogue has been issued of the exhibition row being held at the Science Museum, South Kensington, of representative British and German naval mining and degaussing material used during the Second World War During 1914–18, mines, almost without exception, had to be struck by the target in order to produce an explosion; but in the inter-war period detecting methods were developed which gave the mines greatly increased range of detection. These advances led to the 'ground' mine, laid on the sea-bed, operated either magnetically, electro-chemically or acoustically, or by the small changes of pressure which occur on the sea-bed, on the approach of the target vessel. The antidote to the magnetic mine used extensively by the Germans for the first time in November 1939, was to reduce to a minimum the natural magnetism of ships by a process of 'degaussing'. The exhibition affords a comprehensive insight into the various methods and varied equipment employed, and also contains charts of the British naval mining achievement and of enemy shipping casualties due to British mines in the European war theatre, 1939–45.

Institution of Naval Architects: Awards

The Council of the Institution of Naval Architects has made the following awards: Sir William White Post-graduate Scholarship in Naval Architecture (£150 a year for two years) to Mr. Thomas Corin, of the Ship Division, National Physical Laboratory; Aluminium Development Association Research Scholarship in the application of light alloys to ship construction (£400 a year for two years) to Mr. E. C. B. Corlett; Elgar Scholarship in Naval Architecture (£175 a year) to Mr. R. L. Townsin, of H.M. Dockyard, Portsmouth, who will proceed to King's College, Newcastle-on-Tyne, for three years; Parsons Scholarship in Marine Engineering (£170 a year) to Mr. W. G. Wade, of H.M. Dockyard, Sheerness, who will proceed to King's College, Newcastle-on-Tyne, for three years.

Meteor Observations in India in 1943–44 at Begumpet, Deccan, India

Mohd. A. R. Khan has issued a pamphlet with this title which gives details of meteor observations between January 1, 1943, and December 31, 1944, during a total watch of nearly 132 hours. The observations included the usual well-known shower meteors and in addition a number of exceptionally bright meteors, one of which, in May 1944, was of magnitude − 4. It is interesting to know that the total number observed in each year was nearly the same—1,044 in 1943 and 1,005 in 1944. Details of the paths of all the meteors were sent to Prof. C. P. Olivier, Flower Observatory, who arranged to have the paths plotted and radiants deduced, and a number of new radiants were found as a result. An interesting phenomenon was observed on October 2, 1943, between 21h. and 22h. U.T. The sky appeared to be lit up with a peculiar glow, akin to non-polar aurora. No artificial lights were reported in the neighbourhood at the time, and no explanation has been given of the phenomenon.

Comet Jones (1946 *h*)

This comet was discovered on August 6 by A Jones of Timaru, New Zealand. The following orbit and ephemeris have been computed by Cunningham.

Orbit

T	1946, Oct 27 191 U T	
ω	321° 42′	1946 0
Ω	238 07	1946 0
i	57 10	1946 0
q	1 1121	

Ephemeris

	α	δ
Oct. 19 0 U.T.	13h. 02 9m.	−28° 59′
27	13 41.0	28 25
Nov. 4	14 17 2	27 17
20	15 22 6	23 46
Dec. 6	16 18 5	19 11
22	17 06 4	14 02

Its geocentric distances on the first and last dates are 2 and 2·35, and the heliocentric distances on the corresponding dates are 1·12 and 1·42. Its magnitude on the same dates will be about 7 and 9.

Announcements

A meeting has been arranged by a committee representative of the Society of Authors, Playwrights and Composers, the International P.E.N. Club (English Centre), the National Book League, and the British Association for the Advancement of Science, in memory of H. G. Wells. Lord Beveridge will preside, and tributes will be paid by Prof. G. D. H. Cole, Sir Richard Gregory, Mr. David Low, Mr. Desmond MacCarthy and Mr. J. B. Priestley. The meeting, which is open to the public, will be held in the Royal Institution, Albemarle Street, London, W.1, on October 30, at 3.0 p.m. Applications for tickets should be addressed to the Secretary, Wells Tribute Meeting, c/o The British Association, Burlington House, London, W.1.

Dr. Patrick D. Ritchie, head of the Department of Chemistry and Biology at the Leeds College of Technology, has been appointed head of the Department of Chemistry at the Central Technical College, Birmingham, in succession to Dr. J. A. Newton Friend. Dr. Ritchie is a graduate of the University of St. Andrews, where he was a student of Prof. Alex. McKenzie. On leaving the University he went to the research staff of Imperial Chemical Industries. Ltd., and he has had teaching and research experience in the University of London. Later he became chief chemist to Messrs. A. Reyrolle and Co., Ltd.

Dr. Fred Grundy, medical officer of health for Luton, has been appointed chairman of the Executive Committee of the British Social Hygiene Council in succession to the late Dr. Otto May.

The Leon Gaster Memorial Premium is awarded annually by the Illuminating Engineering Society for the best contribution submitted to and published by the Society during the session. No award was made in 1944. Two awards are being made now, one to Dr. J. N. Aldington for his paper "Bright Light Sources", and one to Mr. G. T. Winch for his paper "Photometry and Colorimetry of Fluorescent and other Electric Discharge Lamps".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Rotating Universe ?

ONE of the most mysterious results of the astronomical studies of the universe lies in the fact that all successive degrees of accumulation of matter, such as planets, stars and galaxies, are found in the state of more or less rapid axial rotation In various cosmogonical theories the rotation of planets has been explained as resulting from the rotation of stars from which they were formed The rotation of stars themselves (in particular that of B-stars) can be presumably reduced to their origin from the rotating gas-masses which form the spiral arms of various galaxies. But what is the origin of galactic rotation ?

If, according to the current theories, we consider the galaxies as the result of gravitational instability of the originally uniform distribution of matter in space, we will find it very difficult to understand why such condensations are in most cases found in the state of rather fast rotation. In fact, on the basis of statistical distribution of angular momentum, we would rather expect such condensations to show no more rotation than the water droplets in a fog formed from over-saturated vapour Barring the possible explanation of the rotation of galaxies on the basis of the alleged irregular turbulent motion of the masses of the universe, we can ask ourselves whether it is not possible to assume that *all matter in the visible universe is in a state of general rotation around some centre located far beyond the reach of our telescopes* [2]

The answer to such, at first sight fantastic, question need not wait until much larger telescopes shall have been built It can be, in fact, settled by present means of observation We know that the rotation of the stars of our system around the galactic centre can be proved by the study of the so-called Oort-effect in the radial velocities of comparatively near stars. In fact, due to the phenomenon of differential rotation, the mean radial velocities of stars located along the galactic plane show a double-sine periodicity with nodal axes directed parallel and perpendicular to the line connecting the sun with the centre of rotation Thus if the realm of galaxies as seen through Mt. Wilson telescope represents only a small part of a much larger system (a 'super-galaxy' in the super-Shapley sense) rotating around a distant centre, careful observations of mean radial velocities of galaxies located in different regions of the sky should reveal similar periodicity.

The existence of this effect would prove general rotation of the universe and indicate the direction towards the rotation centre without, however, giving us its distance. Thus, it seems that the answer to the problem of universal rotation lies within the grasp of modern astronomical technique.

It must be added in conclusion that in the language of the general theory of relativity such a rotating universe can be probably represented by the group of anisotropic solutions of the fundamental equations of cosmology.

G. GAMOW

Department of Physics,
George Washington University,
Washington, D C
Sept 13

Conditions of Escape of Radio-frequency Energy from the Sun and the Stars

IN several communications in *Nature*[1,2,3,4] and elsewhere, various British, Australian and New Zealand workers have described experiments carried out during the War which prove conclusively that during times of solar disturbance there are large outbursts of radio-frequency energy from the sun The wave-lengths measured vary from 1 5 metres to 30 metres (10 Mc to 200 Mc.) On a rough estimate, the intensity of emission appears to be, as Appleton[1] has shown, 10^4 times the value calculated from the black-body formula taking $T = 6{,}000°$ K If we assume that the radiation proceeds only from the active areas, as appears to be corroborated by the experiments now in progress at the Cavendish Laboratory, Cambridge*, the emissivity of these regions for the range mentioned is increased nearly 10^7–10^8 times the black-body radiation

There are certain difficulties in the escape of these radiations from the sun to which attention may be directed It has been found that the quiescent sun has, like the earth, a magnetic field of the order of 50 gauss, but the spots show a field of much higher range, from 100 gauss in the case of tiny spots to 4,000 gauss for the largest ones[5]. If the radio waves are generated anywhere within the outer layers of the sun, then they must follow the physical laws of electromagnetism. According to the magneto-ionic theory of Appleton, an electromagnetic wave of frequency f, generated anywhere on the earth's surface, can escape vertically from the earth only when the frequency of the waves exceeds certain limits, depending upon the maximum electron concentration above. The exact mathematical relations are

$$f_0^2 > \frac{4\pi Ne^2}{m} > 8\cdot 0 \times 10^7 . N$$

$$f_e(f_e + f_h) > \frac{4\pi Ne^2}{m} > 8\cdot 0 \times 10^7 . N.$$

Here N is maximum number of electrons per c c. in the ionosphere, f_o is frequency of the o-wave, f_e is frequency of the two extraordinary waves, f_h the characteristic gyro-frequency of the electrons under the total field H, $f_h = eH/4\pi$ cm $= 1\ 32\ H$ Mc These conditions set a lower limit to the frequency of the radiations which can escape from the earth, and their validity has been verified by innumerable experiments

If we apply these conditions to the sun, and also to the stars, we find at once that severe physical conditions have to be imposed on the emission of radio-waves from these bodies Taking first the o-wave, we should have

$$\begin{aligned} N &< 1\cdot 25 \times 10^{-8} . f^2 \\ &< 1\ 25 \times 10^6 \text{ for } f = 10 \text{ Mc.} \\ &< 5 \times 10^8 \text{ for } f = 200 \text{ Mc.} \end{aligned}$$

The concentration of electrons in the different layers of the sun has been found by well-tried astrophysical methods[6] to have the mean values of 10^{13} per c c for the reversing layer, 4×10^{11} per c.c for the mean chromosphere, and 4×10^8 per c c for the base of the inner corona. It is, therefore, obvious that o-radiations of radio-frequency range which we obtain from the sun cannot have their origin either in the reversing layer or the chromosphere, but only in the corona, and that also progressively in the outer layers as the wave-length is increased But the corona has been shown to be a purely 'electron atmosphere' without any heavier atomic particles, excepting very small concentrations of heavily ionized Fe, Ni and Ca which produce the coronal lines. The mechanism of origin contemplated by Greenstein, Henyey and Keenan[7] which ascribes the radio-waves to recombination between protons and electrons therefore appears to fall to the ground in the case of the sun

The e-waves For the e-waves, the value of f_h is decisive, and this varies from 66 Mc for the quiescent sun to roughly 4,000 Mc for the spot, taking $H = 3{,}000$ These are frequencies of an order which are not contemplated in Appleton's theory, but a little work shows that whatever has been said regarding the o-wave also applies to *that* e-wave which corresponds to the condition $f_e(f_e - f_h) > 8\ 10^7 \times N$ with greater emphasis In fact, this wave cannot escape unless f_e has very high values, > 66 Mc The e-wave corresponds to the condition $f_e(f_e + f_h) > 8 \times 10^7\ N$.

The possibility of reception of this wave on the earth has generally been ignored by European and American workers, but it has been obtained distinctly on several occasions by Toshniwal[8] at Allahabad, and his findings have been confirmed by Leiv Harang[9] Recently, Saha and B K Banerjee[10] have shown that any radio-wave generated on the earth would be decomposed into three waves as in inverse Zeemann effect, the p-component corresponding to the o-wave, and the S-components to the e-waves If this deduction be accepted, we at once see that for the spots, the e-wave of this type has a far greater probability of escape for now we should have

$$\begin{aligned} N &< 1\cdot 25 \times 10^8\ f_e(f_e + f_h) \\ &< 1\cdot 25 \times 10^8\ f_e f_h, \text{ taking } f_h \gg f_e \\ &< 5 \times 10^8 \text{ for 10 Mc waves, and } < 10^{10} \text{ for 200 Mc. waves ;} \end{aligned}$$

taking $f_h = 4{,}000$ Mc , corresponding to the field-strength of 3,000 gauss. For a quiescent sun, the figures are $N < 8 \times 10^6$ and $1\cdot 4 \times 10^8$ respectively Hence the probability of escape of these waves from the quiescent sun continues to be very small, if the wave originates in the deeper layers For larger spots, the field generally increases and has been known to reach values as high as 4,000 gauss.

From these arguments, it is fair to draw the conclusion that the large spots are just the regions whence the e-waves of the frequency range 10–200 Mc can escape The value of the fields given above corresponds to the level where the atomic lines originate, but Chapman[11] thinks that fields might increase to even 10,000 gauss in the deeper layers. If this be true, the e-waves can originate even from much deeper layers Further, it is well known that the spot is a region of far lower temperature, and the electron concentration in the spot is much lower than on the general surface of the sun ; this circumstance also helps the escape of the e-waves

If these considerations be on the right line, the radio-waves received on the earth when a big spot is in the centre of the sun's disk should be circularly polarized, and its sense of polarization will be determined by the sign of the field.

These considerations apply equally well to the stars composing the Milky Way region, from which waves in the metre range have been observed[3]. They cannot be emitted from the surface of the hotter stars, but from cooler stars of G-, K- and M-type, and probably the escape of the radiation is facilitated by the development of spots in these stars, analogous to the case of the sun The difficulties of the dilution factor pointed out by Greenstein *et al* [7] are therefore eased to a large extent, as, according to Dunham[12], the disk area covered by K- and M-stars is nearly 10^4 times that of B-stars

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*I am indebted to Dr J. A. Ratcliffe for showing me these experiments during my recent visit to Cambridge

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Condensations in a Non-static Universe

Einstein and Straus[1] have recently considered the influence of the expansion of space on the gravitation fields surrounding the individual stars The paper has attracted considerable attention, but an interesting new result implicit in their work does not seem to have been noted as yet[2]. The authors consider the cosmological model which, in the usual notation, is

$$ds^2 = -T^2(1 + zr^2/4)^{-2}\ \delta_{ij}\ dx^i dx^j + dt^2, \qquad (1)$$

where $T = T(t)$, $z = 1, -1$ or 0

The pressure vanishes everywhere if

$$2TT + T^2 + z = 0 \text{ or } TT^2 + zT = k, \qquad (2)$$

k being a constant of integration A consequence of the pressure being everywhere zero is that the density ρ is given by

$$\rho = 3k/8\pi T^3. \quad . \quad . \quad . \quad . \qquad (3)$$

Hence

$$(4\pi\rho/3)T^3r^3\ (1 + zr^2/4)^{-3} = m(r), \quad . \qquad (4)$$

is a function of r only. If r is fixed as r_0, m is also fixed and may be interpreted as the total mass contained within the boundary $r = r_0$ Einstein and Straus have shown that Schwarzschild's external line-element in an isotropic non-static form can be made to go over into the cosmological form (1) at $r = r_0$ by defining the constant k of (2) as

$$k = 2mr_0^{-3}\ (1 + zr_0^2/4)^3, \quad . \quad . \qquad (5)$$

where m is the mass constant in Schwarzschild's solution What we wish to point out is that (5) is precisely the relation that one gets from (3) and (4) This fact suggests that if the cosmic matter contained within the sphere $r = r_0$ condenses into a spherical body of the same mass m, there is no change in the external field beyond $r = r_0$ For a given cosmological model of type (1) (that is, for a given k) and for a given r_0 there is naturally a unique m.

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An Observed Abnormal Increase in Cosmic-Ray Intensity at Lahore

DURING the course of an experimental study at Lahore on the directional total intensity of the cosmic radiation, with a triple coincidence counter system, we observed over a short period a very large increase (nearly 200 per cent) in the intensity.

The telescope consists of three internally quenched Geiger-Müller counters, 35 cm. long and 2·5 cm in diameter, spaced 12 5 cm. from each other These counters were prepared with copper oxide coated cylinders and filled with 9 cm. argon and 1·5 cm. pressure of ethyl alcohol vapour, all of them having very similar characteristics and with a plateau of 180 V A stabilized high tension[1] is applied through a resistance of 0 1 megohm to the wires of the counters and the triple coincidence pulses are recorded by a circuit recommended by Johnson[2], which is an improvement on the original Rossi circuit We can set the telescope at various angles to the zenith and also vary the azimuthal angle by a suitable mounting.

During July 31–August 3, with the telescope set vertically, and the axes of the counters in the magnetic meridian, we were getting an average of 23 8 coincidences per hour, and at an angle of 20° W. an average of 16 per hour. The readings were taken during the day-time between 11 a m. and 5 p.m. in the Physics Laboratory, under a single roof of a few inches of concrete. This rate of counts was maintained until noon on August 3, but between noon and 1 p.m. and 1 and 2 p m with the telescope at 20° W., the counting rate increased to an average of 40 per hour, from a previous value of 16 per hour.

Considering it might be due to some fault in the apparatus or local causes, we checked all the voltages, which we found to be very constant. Then we checked and even changed a few valves, but the high rate was maintained. We then rotated the telescope, bringing it to the vertical position again, and between 2 30 and 4.30 p.m took counts in this position, which were also much higher, namely, 60 per hour, as against 24 during previous measurements It is to be noted that in both cases the total counts per hour increased to two and a half times.

On August 4 (Sunday) we took no observations. On August 5 about the same rate of coincidences as originally was restored, and the observations were normal.

The enhanced intensity lasted at least for five hours, probably longer, and checking up all the facts we are inclined to believe that it was a real increase in the intensity of the radiation. We shall be interested to learn if during the same interval the same abnormal increase was observed elsewhere; or whether it was shown only in a particular region of the earth

Our thanks are due to Prof. J. B. Seth, Dr. P. K. Kichlu and Dr. P. S. Gill for their encouragement in this work.

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Refraction Effects in Electron Diffraction

OBSERVATIONS by Sturkey and Frevel[1] and Hillier and Baker[2] indicate that some rings in electron diffraction patterns from magnesium oxide and cadmium oxide smokes are double, and in one case (the *220* ring) it was suspected that there were five components contributing to the ring contour. Sturkey and Frevel suggested that refraction by the regularly shaped particles gave rise to the two components, although their data were not conclusive Using the high-resolution system of the R C A. type E M U microscope as a diffraction camera, we have attempted to find some feature of the diffraction by oxides of this type attributable to stoichiometric excess of the metallic constituent. We have obtained patterns showing resolution of details of fine structure of the reflexions, from which a complete interpretation of the phenomenon is possible

Patterns from magnesium oxide and cadmium oxide smokes, both of which occur as regular cubes of about 500 A cube-edge, show rings to be double, triple, or, in the case of *h00* reflexions, single and sharp In certain cases when orientation (cube faces normal to beam) was present, tilting of the plane of the specimen produced arc patterns from which information concerning the dependence of the multiplicity on the angle of tilt could be obtained In patterns to which few individual crystals contributed, it was observed that spots were grouped about the position at which the normal reflexion was to be expected and that often groups of six were observed Furthermore, the *h00* rings, although single, consisted of groups of two component spots displaced along the ring Where larger deviations from the stoichiometric ratio existed, the spots were replaced by streaks radiating from the expected position of the reflexion For example, yellow cadmium oxide gave spot patterns, whereas brown cadmium oxide, containing greater excess of cadmium, gave streaks These effects are illustrated in enlargements (× 56) of small segments of certain rings (Fig. 1).

The angular deviation δ expected on the basis of refraction due to an inner potential P volts may be shown to be

$$\delta = \frac{P}{2E}\left(\pm\frac{\cos\psi_1}{\cos\varphi_1} \pm \frac{\cos\psi_2}{\cos\varphi_2}\right),$$

where φ_1 and φ_2 are the angles between the beam and the face normals, ψ_1 and ψ_2 are the angles between face normals and the diffraction plane normal, and E is the accelerating voltage of the electron beam This reduces to

$$\delta = \frac{P}{2E}\ (\pm \tan\varphi_1 \pm \tan\varphi_2),$$

in the special case where the path of the beam lies in a plane perpendicular to the cube edge (see also ref 1)

On the basis of this theory, it has been possible to interpret the features of the patterns obtained The calculated variations in separation and relative intensity of the several components of the arcs with angle of tilt agreed with those observed Agreement between the observed and calculated values for the angles between the individual streaks of one group and the radius of the ring was also obtained Calculated inner potentials varying from 12 to 16 volts for the various planes lie in the range expected Only a variation of inner potential, resulting, we suggest, from the presence of excess metal atoms in

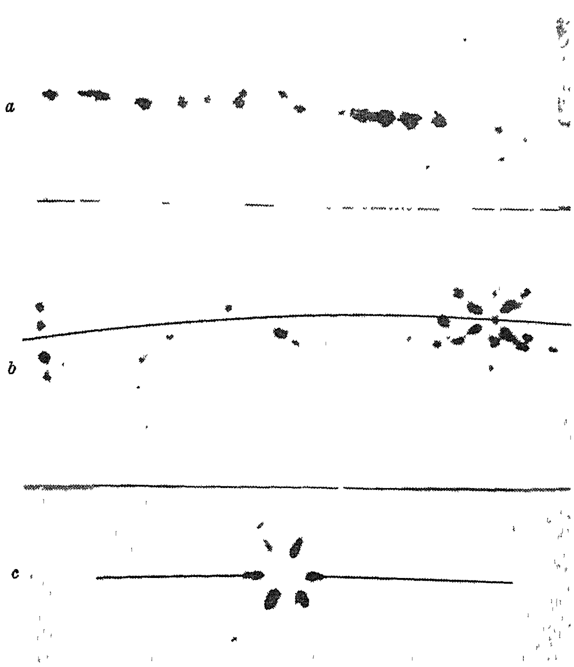

Fig 1 EXAMPLES OF GROUPS OF REFLEXIONS RESULTING FROM REFRACTION BY CUBES OF MAGNESIUM OXIDE FOR (*a*) (200), (*b*) (220) and (*c*) (422) PLANES UNDISPLACED RING POSITIONS ARE INDICATED BY THE CONTINUOUS LINE IN (*b*) AND (*c*). ENLARGEMENT FROM ORIGINAL PATTERN, 56 DIAMETERS

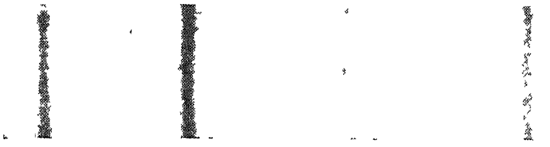

Fig 2 PORTION OF ELECTRON DIFFRACTION PATTERN FROM CADMIUM OXIDE PARTICLES, SHOWING DIFFERENT LINE BREADTHS FOR *222*, *400*, *420* AND *422* REFLEXIONS ENLARGEMENT 16 DIAMETERS

interstitial sites in the crystal, can explain the elongation of component spots into streaks

Progressive change from regular cubic to irregular habit was accompanied by the merging of the individual components into one broad ring For zinc oxide smoke particles, where only the prism faces parallel to the hexagonal axis are well developed in the characteristic long spines, only one pair of streaks is expected from each single-crystal reflexion Hillier and Baker[3] have observed these streaks for zinc oxide smoke and have interpreted them as low magnification electron-optical images of the individual spines If this were so the streaks would be radial on the *002* ring and circumferential on the *100*, whereas in the patterns obtained by us, and in those published by Hillier and Baker, the opposite is the case, in accordance with the refraction theory.

For spherical particles, or the similar case of completely irregular shapes, the refraction effect will produce a broadening of the rings of calculated angular half-width $1{\cdot}4\,\frac{P}{2E}$, and width for one tenth intensity $3{\cdot}8\,\frac{P}{2E}$. This broadening is of the same magnitude as that due to finite crystal dimensions for particles of only several hundred angstroms diameter for voltages most commonly used, and so must be taken into account in crystal-size determinations. For regularly shaped particles the estimation of particle shape and dimensions on the basis of ring breadth must likewise take into account the selective broadening of the rings by refraction, which may be as large as $\frac{5P}{2E}$ (Fig. 2). Moreover, in this case the relative intensities, as judged by peak intensity values, will be smaller for those rings undergoing refraction-broadening, thus giving rise to apparent intensity anomalies in electron diffraction patterns Particles having well-developed crystal faces will therefore show deviations in relative intensity of the various reflexions from the X-ray values In contrast to the explanation offered by Ehrhardt and Lark-Horovitz[4], this is the case with zinc oxide, where the relative intensities of the *110* and *103* rings, in particular, are inverted for material showing hexagonal prism habit

Details of this work will be published in full at an early date.

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'Container-dent Sensitivity' of Solid Explosives

WHEN explosions result from rough handling of bomb-type ammunition, they generally must be ascribed to accidental fuse action, because, with fuses generally present, alternative explanations appear less reasonable But during the War there have been some explosions of items of bomb-type ammunition where (with partial detonations) fuses were recovered intact, and other cases where bomb-type ammunition items were exploded without any fuses in them The impacts which resulted in these explosions were caused by only relatively light bumping, or by the items falling from heights ranging from 4 in. up to 4–5 ft ; and they were too slight to have caused rupture or more than mere dents

This phenomenon, now called 'container-dent sensitivity', differs essentially from 'bullet sensitivity', or from 'fragment sensitivity', which produce detonations of explosives in thin metal containers when such containers are penetrated by bullets or fragments at high velocities of the order of 2,000 ft/sec or more (but are only ignited, or are unaffected, at much lower, though still 'penetrative', velocities).

Also, this phenomenon is by no means the same as that involved where an even greater height of fall of a small weight is used to explode a few milligrams of *bare* explosives in conventional 'impact sensitivity' tests. Its existence seems, in fact, not implied by results of usual explosive sensitivity tests, and it appears to have had little or no important mention in the literature of explosives.

Dents on U.S. bomb-type ammunition caused by impacts at least as severe as impacts causing these occasional explosions probably occur by the million ; so that explosions from denting impacts are fortunately of extremely low frequency. With U S. bomb-type ammunition during the War there have been only about twenty incidents probably ascribable to this cause ; but they have included particularly bad ones which, by one rough estimate, involved total property losses of many millions of dollars, and thousands of deaths and injuries.

Such occurrences seem more frequent with the more sensitive explosives, but T.N.T and amatol, as well as R.D.X. explosives, have all been involved. Very thin-walled containers, such as those of depth bombs and torpedo war-heads, appear relatively more susceptible One may surmise a trivial local ignition is produced by certain unidentified critical conditions of denting, and that burning to partial or complete detonation is peculiarly favoured by confinement afforded by the dented, but unbroken, container

Adequate understanding of the mechanism of this phenomenon apparently requires further fundamental research, which possibly may result from more widely disseminated knowledge of the existence of 'container-dent sensitivity' and from fuller appreciation of its practical importance.

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An Electronic Method of Tracing the Movements of Beetles in the Field

RECENTLY a new form of Geiger-Muller tube has been developed (by G. A R T) which has been found extremely useful in studying the movements of Elaterid beetles of the genus *Agriotes* Esch. As these beetles are known to fly but rarely in Britain a study of the extent to which they may move by walking is of considerable interest

A beetle is taken from the field, and 5 μgm. of radium sulphate, deposited between aluminium foil disks (2 mm in diameter and weighing in all only 0·5 mgm), are inserted with resin adhesive beneath the elytra. The beetle is replaced, and its position afterwards found by detecting the radiation from the disk with a Geiger-Muller tube The tube, which has the advantage of quiet background, stable operation, and high sensitivity, together with its associated power supply, operates a loudspeaker directly, without any valve amplification, and is thus very convenient for field use When it is passed over the region in which the beetle is thought to lie, periodic ticks increase in frequency to a maximum when the tube is directly overhead. The quantity of radium sulphate used is sufficient to enable localization through four inches of soil and the beetle's position may thus be ascertained to within a few inches with only the preliminary interference of marking, although it is quite invisible, either at night, or by day under soil, or among the dense stem bases of meadow plants.

It is probable that this robust apparatus will find many applications in ecological field work in the future.

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Statistical Weather Forecasting

IN the regression equation

$$P = K_1x_1 + K_2x_2 + \ldots K_nx_n, \quad . \quad (1)$$

characteristic of all equations employed in statistical weather forecasting, including long-range forecasting, let P represent the atmospheric pressure at a station A at time $t = z$, $x_1 \ldots x_n$ representing the pressures at n evenly spaced points on a circle of unit radius at time $t = 0$. This equation serves to predict the value of P for a time z in advance, and the well-known method to obtain the n unknown regression coefficients is to apply the method of least squares :

$$\Sigma(P - K_1x_1 - \ldots - K_nx_n)^2 = \min. \quad (2)$$

in which the summation extends over a long series of previous records

If the differentials of (2) with respect to the K's are each equated to zero, there emerge n linear equations

$$r_{Aq} = \sum_{s=1}^{n} K_s r_{qs} \; (q = 1, 2 \ldots n). \quad . \quad (3)$$

In (3) r_{Aq} denotes the correlation between P and x_q, and r_{qs} that between x_q and x_s

The reliability of the predicted P depends upon the closeness with which R_z, the multiple correlation coefficient between P and $x_1 \ldots x_n$, approaches unity ; where, according to a well-known theorem of correlation theory,

$$R_z^2 = \sum_{q=1}^{n} K_q \, r_{Aq}. \quad . \quad . \quad . \quad . \quad (4)$$

If the number of 'control stations' n be increased indefinitely the above equations assume the form

$$r_{(Aq)} = \int_0^{2\pi} K_{(s)} \, r_{(qs)} \, ds, \quad . \quad . \quad . \quad (5)$$

and

$$R_z^2 = \int_0^{2\pi} K_{(q)} \, r_{(Aq)} \, dq. \quad . \quad . \quad . \quad (6)$$

The practical application of these equations was performed as follows. Correlations between the daily pressures at a large number of barometric stations in South Africa were computed for the five-year period 1936–40, Pretoria serving as station A. By drawing a map showing lines of equal correlation, it was possible to determine the value of $r(A_q)$ at all points on a circle of roughly one thousand miles in diameter covering the greater part of the Union of South Africa, and to express $r(A_q)$ analytically in terms of its harmonic components. Similarly, by drawing a series of maps showing lines of equal correlation of *simultaneous* pressures, it was possible to express $r(q,s)$ in terms of a double Fourier series involving the two variables q and s. By substituting the values thus found in (5), one is able to obtain the value of $K(s)$ in terms of its Fourier components, and hence the value of R_z by means of equation (6).

The value actually found for the month of July was

$$R_z = 0{\cdot}916 \pm 0{\cdot}003,$$

and this value represents an accuracy of prediction which compares most favourably with the accuracy obtained by competent meteorologists in drawing prebaratic or prognostic charts.

However, the above value of R_z by no means represents the ultimate possibilities of this method. The maximum value of R_z, which in a previous publication[1] we denoted by M_z, is attained only when all possible controls are included, which implies that pressures at *all* points in the atmosphere measured at *all* times from $t = -\infty$ to 0, should be included in the regression equation. This in turn means that the single integration in (5) and (6) should be replaced by a four-fold integration with respect to space and time to obtain the value of M_z and hence the maximum reliability of prediction.

From the example quoted it will be evident that this method, in which a system of linear equations is transformed into a single integral equation, opens up a very wide field of research, and by the systematic investigation of the value of M_z when z ranges, say, from 6 hours to 6 months, a final verdict may be reached concerning the possibilities and limitations of both medium and long-range weather forecasting.

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"Turbulent Flow in Alluvium"

PROF. C. M. WHITE, in commenting on Mr. Gerald Lacey's letter on "Turbulent Flow in Alluvium" published in *Nature* of August 3, p. 166, stated, "Mr. Gerald Lacey has discussed the dimensions of rivers flowing in beds of incoherent alluvium . . ."

This is not quite correct. Mr. Lacey's original formulæ of 1930[1]—which remain substantially the same to-day, sixteen years later—were based on a considerable mass of accurately measured data observed in canal channels in which the discharges were maintained nearly constant. Since then, much more data have been collected—in many cases at intervals throughout the year—by specially trained staff, in channels which do not change appreciably from year to year, and are run with almost constant discharges. These data have been statistically analysed and it has been found that the more data that become available, the better the agreement with the Lacey formulæ.

The formulæ presented by Mr. Lacey in his letter are not new, except in their form of presentation, and were inherent in his original formulæ.

What he has done is to substitute

$$f_{SV} = 48\sqrt{SV} \propto (\nu g)^{1/6}$$

as a sand factor, in place of the earlier

$$f_{VR} = 1{\cdot}155\, V^2/R \propto g.$$

Lacey makes these equal numerically at regime, but they are different dimensionally, due to gravity and kinematic viscosity being omitted for simplicity; because they were designed for use by practical engineers.

All Lacey's formulæ are based on two fundamental relationships

$$\frac{gDS}{V^2} \text{ or } \left(\frac{V^*}{V}\right)^2 \text{ and } \frac{V^2}{\frac{1}{2}gw} \text{ (the Froude number for width),}$$

$$\text{and } \frac{gDS}{V^2} \text{ and } \left(\frac{VD}{\nu}\right) \text{ (Reynolds' number).}$$

Surely Prof. White does not suggest that "On algebraically combining two such formulæ one could prove anything"!

Next as regards what should be treated as "independent variables": Prof. White has adopted Q, g, Vs—the terminal speed of a typical particle falling through water—and N—the quantity of solids expressed as a fraction of the water flow; and he has selected the area of cross-section at bank-full stage as a dependent variable. He then eliminates N by grouping rivers in which the charges, *as measured*, vary between 1/1,000 and 1/5,000, but he has not stated how such measurements were observed, nor has he yet presented the data of the ten selected rivers on which his formulæ were based.

Experiments carried out by me at Poona[2] showed that the rate of deposition of sand of various grades in turbulent water varies as $(N.Vs)$—that is to say, a heavy charge of silt gives the same rate of deposition as a correspondingly lighter charge of medium sand—so that if the charge—N—varied between 1/1,000 and 1/5,000, either bed movement must have been ignored—as seems probable, because no method of measuring movement of bed sand outside a research station has yet been devised—or else a wide range of charge must have seriously vitiated the results—unless, of course, there was so little movement that charge was an unimportant factor. This is what Lacey assumed for his regime conditions.

There is little difference, therefore, between Lacey's original selection of variables and White's.

		Lacey's original independent variables	White's independent variables
1	Q	Accurately measured practically constant discharges	Discharge observed at bank-full stage assumed to represent normality.
2	N	Regime charge—the minimum charge associated with a fully active bed	A range of charge from 1/1,000 to 1/5,000 assumed not to affect results appreciably.
3	f, Vs	f, a sand factor originally linked with V^2/R but later with $\sqrt{SV}$.	Vs, the terminal velocity of what is called a typical particle.

As regards Vs, experience in India shows that the material exposed on the bed of a channel is continually varying, both as regards grade (Vs) and charge(N). That, in fact, changes in N and Vs represent the 'mechanism of adjustment' to meet changing flow conditions. Thus N and Vs are highly dependent variables, the former of which cannot be measured with any degree of accuracy outside a research station and the latter only with difficulty—because samples of bed material have to be taken at the same time as the area of section, discharge and water temperature are observed.

It may be argued that (SV) is an equally poor criterion of independence—on the grounds that S and V are both dependent variables—but S can only alter very slowly, and experience shows that with constant discharge, but varying charge and grade, $V = (Q/a)$ also alters slowly, and that (SV) alters still more slowly. Thus, though S and V depend on rainfall, the material washed into the river, the temperature of the water, and the variations in all of these—which cause 'trading' of material during alternating conditions of scour and accretion—yet (SV) is the best measure of the integrated effects of sand charge and grade on a long-term basis and probably also on a short-term basis, because it is easily measurable and is proportional—after eliminating the effects of discharge—to the overall effects of charge, grade, shape and specific gravity of particles, and water temperature.

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[1] Lacey, G., *Proc. Inst. Civ. Eng.*, 229 (1930).
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PROF. C. M. WHITE, in his valuable and constructive comments on my new flow equations[1], has raised certain questions, which, if the subject of alluvial transport is to be further advanced, demand a reply.

The Lindley theorem[2] of 1919, of which my 1930 equations were a natural outcome, asserted that for a given discharge, particle size, and transported load, the dimensions of a channel flowing uniformly in an unlimited medium of its own self-transported alluvium are, ultimately, uniquely determined. The dependent variables are therefore P, R and S, the wetted perimeter, hydraulic mean depth, and water surface slope.

The conditions postulated are ideal and more easily achieved in the laboratory than in the field. On well-established perennial canals, the conditions in respect of discharge, particle size, and transported load are tolerably fulfilled. The engineer, however, by somewhat arbitrarily assigning width, depth and slope, when constructing his canals and making his excavations in the natural soil, presents Nature with the immediate task of modifying the designed depth of water, followed by a further adjustment in depth and slope which is also accompanied by modifications in the width if the soil is friable and permits of this taking place.

The 1939 equations of Prof. White are effectively an application of the Lindley theorem to rivers, and in particular to those rivers in the alluvial plains which by a cycle of erosion and accretion have generated their own cross-sections and established a slope which can correctly be regarded as a dependent, as opposed to the sensibly constant and independent variable of the slope of shingle and boulder torrents, of which the actual size of bed particle exposed at any given time is a dependent variable and a function of the discharge intensity. Rivers in the plains generate their own boundaries and slopes, but, owing to the admixture of fine adhesive particles and 'ageing', the banks and portions of the bed are frequently far from incoherent. As a result, if the gross slope is measured over many miles, this slope is not a simple dependent on the cycle of discharges and the particle size, but is complicated by the addition of other factors leading to loss of energy and an increase in the slope. The poor correlation of Prof. White's slope equation is probably due mainly to this cause.

The dependent variables of P, R and S having been assigned, all other variables, known, or unknown, are independent, and Prof. White's method of dealing with them is highly ingenious and effective. Failing measurement of the transported load, N, we are forced either to treat it as constant, or to adopt a criterion in which both particle size and load are implicit.

Prof. White has directed attention to the impropriety of combining two empirical equations algebraically. With his contention I fully agree, but would submit that when the two equations have each a high correlation, and the merit of extreme simplicity in the powers, the ends may justify the means, and serve to demonstrate the truth of past experience that more than one advance has owed its existence to a leap in the dark, ending happily on firm ground.

The risk, to which Prof. White has referred, that one may derive two empirical equations "which look different but which do in fact state the same thing though containing different errors of field measurement", is one that all unwittingly may run.

The dimensionless number of Prof. White

$$ag^{2/5}/Q^{4/5}$$

is possibly not quite so simple as it appears, and I certainly prefer as an alternative

$$aVs/Q,$$

which can be rewritten

$$Vs/V.$$

When this substitution is made, the two White equations become respectively

$$Vs/V = 2{\cdot}40\ (Vs/g^{2/5}Q^{1/5})^{0{\cdot}78}, \qquad \text{W}(1a)$$

and

$$S = 0{\cdot}0120\ (Vs/g^{2/5}Q^{1/5})^{0{\cdot}90}. \qquad \text{W}(2)$$

Now, if we demand of our equations that they possess a physical significance, the conclusion is inescapable that, for a constant load N,

$$Vs/V \propto S,$$

and

$$Vs \propto (VS).$$

I conclude that owing to the complex nature of Prof White's dependent slope variable, and the relatively large errors of field measurement, both in S and Vs, he has inadvertently succeeded in deriving two different equations for the same concept, slope His terminal velocity of the particle Vs plays the same part as the criterion I have adopted (VS), and I have no doubt that when he examines a more extended and reliable collection of data he will succeed in reconciling his two powers of 0 78 and 0 90 respectively. The arithmetical mean of the two powers is 0 840 and differs very little from my power of 0 833

I would be the last person in the world to suggest that "bed material is unimportant"; but it is indeed important to note that an equation can be derived in which it is implicit. I would direct the attention of the engineer to the equation

$$S = 2^{1/6}\ (VS)^{5/6}/(g^2Q)^{1/6}, \qquad (6a)$$

in which (VS) associates particle size with transported load, and is a convenient description of any alluvial channel. To the physicist, I recommend investigation of the new basic equation

$$S = 2V^5/g^2Q. \qquad (6)$$

An expression of this form may ultimately prove to be universal in its application

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[1] *Nature*, **158** 166 (1946)
[2] Lindley, E S, Proc Punjab Eng. Congress, **7** (1919).

Effect of Environment on the Reactivity of High Polymers

DURING the polymerization of vinyl compounds, in the pure state and in solution, it is frequently observed that the reaction-rate curve is of the 'autocatalytic' type, the velocity increasing as the reaction proceeds. Hitherto this has been attributed to (*a*) non-isothermal character of the reaction, (*b*) to the fact that the catalyst, or its products of dissociation if present, does not immediately react with the monomer. In 1941 Schulz and Blaschke[1] observed a similar increase in the velocity after about 20 per cent polymerization when neither of the above explanations was valid Similarly, Norrish and Smith[2] found the same phenomenon in solution, the increase in velocity being the more marked the poorer the solvent for the polymer produced. Again, Trommsdorff[3] found that if the viscosity of monomeric methyl methacrylate were increased by the addition of cellulose tripropionate, the velocity of polymerization and also the molecular weight of the polymethacrylate both increased.

The increase in rate might have been due (*a*) to an increase in rate of initiation of polymer chains, (*b*) an increase in the rate of propagation of growth, termination occurring by the mutual interaction of the ends of the active polymer. The effect could be produced either by an increase in viscosity of the solution or by precipitating the polymer out of solution, probably in the act of growing An increase in (*a*) is not compatible with the observed increase in molecular weight, for normally an increase in (*a*) would lead to a decrease in molecular weight, and it is unlikely that (*b*) would be affected for it is difficult to see how this rate could increase.

The most probable explanation appeared to be that the rate of termination was cut down As the liquid became more viscous, the ends of the active polymer would find it more difficult to diffuse into each other's proximity and interact and so terminate growth In the case of a bad solvent the active polymer would then be so coiled up that again the active ends would not easily gain access to each other. Thus in both cases the rate of polymerization would increase simply owing to a diminution of the speed of reaction responsible for cessation of growth.

Recently a method has been developed[4] for measuring the individual values of all the velocity coefficients in a polymerization reaction, and hence it appeared feasible to see whether in fact the above suggestions would account for the behaviour observed Using the solvent technique with vinyl acetate and photochemical initiation of the reaction, precisely similar phenomena have been observed. In a good solvent such as ethyl acetate, the reaction is normal and exactly similar to that in the pure monomer, in a bad solvent such as n-hexane, the autocatalytic character of the reaction is clearly marked. The accompanying table shows the results obtained in the normal phase of the reaction and after acceleration had set in

Rate of initiation of chains = 6 0 × 10^{-8} mol lit $^{-1}$ sec $^{-1}$. Temp 25° C

	Normal	Abnormal*
Overall rate (mol. lit $^{-1}$ sec $^{-1}$)	5 0 × 10^{-6}	1·1 × 10^{-5}
Life-time of active polymer (sec)	8 1 × 10^{-2}	17·0 × 10^{-2}
Growth coefficient, k_p (mol.$^{-1}$ lit sec $^{-1}$)	7 0 × 10^{2}	6·8 × 10^{2}
Termination coefficient, k_t (mol.$^{-1}$ lit sec $^{-1}$)	2 6 × 10^{9}	5 0 × 10^{8}

* After 5 per cent of polymer has been formed

It is of importance to note that the values of k_p and k_t for the pure monomer, namely, 6 7 × 10^2 and 2 5 × 10^9, are in excellent agreement with those for the normal phase of the reaction. In the abnormal phase of the reaction, however, only the termination coefficient is affected, thus vindicating the suggestions made previously The agreement is quantitatively satisfactory, for a two-fold increase in rate would correspond to a four-fold reduction in the termination coefficient, as is approximately observed. Thus the reactivity of growing polymer molecule is affected by the environment in which it is placed, provided that it interacts with another of its kind Immobility or coiling up as in a bad solvent or in the gas phase cuts down reactivity On the other hand, when a monomer interacts with the polymer, its high mobility permits it to penetrate to the active spot under all conditions, and environment has no effect A great many parallel observations on reaction of this kind all fall into quantitative agreement when this new kind of effect is taken into account.

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Alginic Acid Diacetate

BELIEVING that the usual methods of acetylation give degraded products, Wassermann[1] has attempted to acetylate alginic acid with ketene By this means he succeeded in introducing approximately one acetyl group into each repeating unit of the polymer Some years ago we studied the action of ketene on alginic acid under various conditions, and although products with a higher acetyl content (20 9 per cent) than Wassermann's were obtained, the method was abandoned in favour of a simpler and more effective procedure[2]

When alginic acid is dried, hydrogen bonding between neighbouring molecules is so severe, and the structure is so compact, that reaction with acetic anhydride is impossible If, however, the alginic acid is first swollen in water, the hydroxyl groups become available for acetylation and remain available when the water is displaced with glacial acetic acid Making use of this principle, alginic acid yarn[3] can be acetylated without loss of fibre-form in the following way the yarn (1 0 gm) is swollen in water, centrifuged and then immersed in several changes of glacial acetic acid until the residual water is less, preferably very much less, than 30 per cent of the original weight of the yarn The latter is then transferred to 30–40 c c of a mixture having the following composition: benzene 180 gm, acetic anhydride 60 gm. and sulphuric acid (conc) 1 2–1 5 gm The reaction is allowed to proceed for 24 hours at 25° C, or for 1 hour at 25° C., followed by 15 minutes at 50°–60° C Perchloric acid can be used in place of sulphuric acid, and either catalyst can be introduced by swelling the yarn with a 1·0 N solution of the acid instead of with water, in this case, acetylation is carried out with a mixture of benzene and acetic anhydride, benzene being present simply to ensure preservation of fibre form

Yarn acetylated for 17 hours at 25° C. in the above manner gave a 97 3 per cent yield of the di-acetate (acetyl. found, 33 0 per cent; theory, 33 1 per cent) Determinations of the tenacity of the acetylated yarn, its solubility in water, and other properties showed that acetylation had been achieved without any appreciable degree of degradation

As would be expected, alginic acid di-acetate swells, but does not dissolve, in water, methanol, ethanol, acetone, dioxan and glacial acetic acid at ordinary temperatures It dissolves at once in aqueous acetone (80 per cent) and, surprisingly enough, in view of the insolubility of calcium alginate, in 0 5 N calcium acetate. Similarly, no precipitate could be obtained when solutions of calcium chloride, barium chloride, copper sulphate, lead acetate and ferric chloride were added to a solution of the di-acetate in 0 1 N sodium acetate

The di-acetate undergoes slow hydrolysis on exposure to air at 65 per cent relative humidity and 22 2° C, as is indicated by the following data for yarn acetylated in presence of sulphuric acid

Time of exposure (days)	Acetyl content (per cent)
0	33 6
20	31 5
40	30 4
100	26·4
220	18 9

Similar results were obtained with yarn acetylated in presence of perchloric acid.

A full account of the preparation and properties of the di-acetate and other esters of alginic acid will be published elsewhere We are indebted to Alginate Industries, Ltd., and Courtaulds, Ltd., for grants in aid of these investigations.

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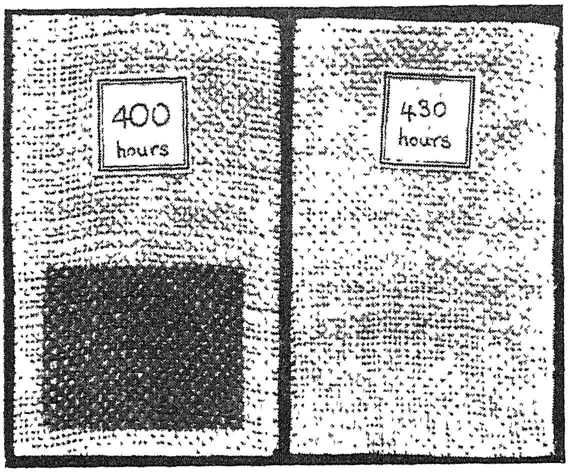
Permanent Bleaching of Ligno-Cellulosic Materials

At the present time the bleaching of ligno-cellulosic materials such as sisal, jute and manila is, as normally carried out, of only temporary efficacy, for the bleached materials gradually discolour again on exposure to sunlight

It has now been shown that this discoloration may be prevented and bleaching thereby rendered permanent by subjecting the materials to certain esterification and etherification treatments, particularly acetylation, benzoylation and methylation

Acetylation has been carried out in a number of ways by means of acetic anhydride in the presence of various acidic and basic catalysts. Benzoylation has been accomplished by treatment with benzoyl chloride in the presence of pyridine at about 100° C. Both these processes have been employed to give complete protection against light discoloration A marked, though only partial, effect has been obtained on methylation by successive treatments with ethereal diazomethane Methylation with dimethyl sulphate in the presence of strong alkali has also been found to be partially effective, but in this case the effect is accompanied by considerable damage to the fibre.



In the photograph, untreated jute, of which a limited area was exposed to the light of a carbon arc lamp for 400 hours, is shown on the left. The degree of discoloration is considerable. On the right is a sample of acetylated fabric in which the equivalent area was exposed for an even longer period. In this case no discoloration at all is perceptible.

It is tentatively suggested that the cause of the discoloration is to be found in the reactivity of the phenolic groups of the lignin present in these fibres, which, under the influence of light, tend to polymerize to coloured quinones. By causing the reactive phenolic groups to combine with alkylating or acylating agents, therefore, the discoloration is prevented

I am indebted to the Sisal Growers' Association for permission to publish this note.

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Effect of Hydrogen Peroxide in the Presence of Copper Sulphate on the Shrinkage of Wool

Nilssen[1] has reported that chlorine dioxide imparts an unshrinkable finish to wool when applied in a solution from carbon tetrachloride Experiments have been conducted to examine the effect of oxidation by hydrogen peroxide in the presence of a copper salt on the shrinkage of wool.

The knitted fabric used was made from 60's quality, count of yarn 1/15, circular knit, and the degree of shrinkage through felting was determined by reduction in area during hand milling at about 50° C. in an aqueous solution containing 5 per cent soap and 0 2 per cent sodium carbonate All measurements were made after the samples had been relaxed by soaking in water for about ten minutes Samples measuring in each instance about 30 sq in in area were immersed in 600 ml. of 0·4 per cent hydrogen peroxide to which 25 ml of 5 per cent copper sulphate solution had been added and which had been brought to pH 4 2 with 5 per cent sodium bicarbonate solution. Lipson[2] has shown that pH 4·2 is the value for maximum attack.

The solution was brought to the boil in ten minutes and maintained at the boil for ten minutes. After washing in running water for one hour, the samples were measured and then milled for about fifteen minutes with measured control samples. The percentage reduction in area during milling was 40 per cent and 15 per cent for the control samples and treated samples respectively.

It was found that by soaking the samples before milling, for five minutes, at room temperature (17° C.) in 5 per cent sulphuric acid solution, the shrinkage during milling in the treated samples was reduced further, The reduction in area was 37 per cent and 3·5 per cent for the control samples and treated samples respectively

Using the apparatus devised by Lipson[3], frictional measurements were undertaken to discover if the treatment affected the directional frictional effect. The values before and after treatment were found to be the same

Experiments were carried out to determine the effect of the treatment on the extensibility of the fibres After treatment, fibres were found to be more easily extensible, yet the ability to recover from deformation was not impaired Thus it appears that the unshrinkable finish is produced by means which differ from those suggested for the majority of other anti-shrink reagents, namely, reduction of directional frictional effect or reduction of extensibility of the fibre

It is intended to publish a detailed account of this work in the *Journal of the Royal Society of New South Wales* The interest shown and constructive criticism provided by Mr M R Freney, officer in charge, Australian Wool Realization Commission Testing House, is gratefully acknowledged. Thanks are also due to Mrs P Harris for valuable assistance with the frictional measurements and to Dr F P Dwyer for help in preparation of this communication

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Man's Reaction to Mosquito Bites

It is widely known that different individuals give very different reactions to the bites of insects, and also that repeated exposure may alter the reactions of one individual (Boycott[1], Hecht[2]), but surprisingly little work has been done on this subject The availability of a group of human volunteer subjects for medical research made it possible to investigate the effect of the bites of various species on individuals who could be kept under observation for long periods

In the first series of experiments, the yellow fever mosquito *Aedes ægypti* was used, and only subjects who had never travelled outside Britain, and who were, therefore, unlikely to have been previously bitten by this species, were exposed Twenty-five volunteers all gave a similar reaction When bitten by *A. ægypti* for the first time there was no immediate cutaneous response, other than a tiny red spot about 1 mm in diameter at the site of the bite, and no itching was observed. After a variable period, however, usually between twenty and twenty-four hours, a marked delayed reaction occurred A red patch about 3 cm in diameter surrounded the bite, and the central 1 cm was seen to form a definite weal. This condition was observed over several days, the itching and other symptoms waxing and waning several times

The volunteers were bitten by *A. ægypti* on several occasions for about a month, and at the end of that period the reaction was markedly different An immediate reaction had developed—as soon as the mosquito had fed, a weal developed at the site of the bite, an area of erythema appeared surrounding the weal, and the skin itched. Within two hours all these symptoms disappeared completely, but after twenty to twenty-four hours the same delayed reaction noticed on the occasion of the earlier exposures appeared

After a further period of exposure there was another modification. The immediate reaction persisted unchanged, but the delayed reaction got gradually less severe and eventually disappeared. This meant that the bites were less troublesome to the victim

The volunteers never got beyond this stage, but in other individuals who have been repeatedly exposed to thousands of bites from *A. ægypti* I have observed that the immediate reaction also disappears

Man's reaction to the bites of this species may then be tabulated as follows . each stage is reached after further exposure

	Immediate reaction	Delayed reaction
Stage I	−	+
,, II	+	+
,, III	+	−
,, IV	−	−

I suggest that these two reactions are quite distinct and are probably caused by different antigens in the saliva of the mosquito

Other experiments have been carried out with *Anopheles maculipennis atroparvus* Most men when first bitten gave the stage I reaction, and it seems likely that the minority who gave stage II (three out of twenty-five volunteers) had had previous exposure to the mosquito. After exposure, the immediate reaction was developed, and in some cases stage III was reached I have not yet produced stage IV experimentally, but have observed it in individuals known to have been exposed to this mosquito for several years.

The sensitization and immunity in these delayed and immediate reactions seems to be specific. Thus one man may simultaneously give a stage I reaction to *Anopheles* and a stage II reaction to *Aedes*.

Other species of biting insects appear to give results which fit into the same scheme, with minor modifications. Most human beings appear to give very similar results when subjected to the same degree of exposure, though special cases of hypersensitivity and severe allergy also occur

The whole problem is under further investigation.

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Penicillin as a Plant Hormone

In the course of investigations on the effects of some antibiotics on plant tissues *in vitro*, it was discovered that commercial penicillin sodium (Squibb) has a potent effect on the growth of excised fragments of sunflower stem tissue cultured on White's sucrose mineral agar. A concentration of 500 units per c.c. of this substance caused great proliferation of the cambial tissue without production of visible roots

EFFECT OF COMMERCIAL PENICILLIN SODIUM ON THE GROWTH OF SUNFLOWER STEM FRAGMENTS *in vitro*. (*a*) 500 UNITS PER C.C., (*b*) 5 UNITS PER C.C., (*c*) NO PENICILLIN. (PHOTOGRAPH BY J. A. CARLILE.)

(Fig. *a*). 5 units per c.c. also caused proliferation of cambial tissue accompanied by an abundant production of roots (Fig. *b*). Stem tissue cultured in the absence of the antibiotic showed neither proliferation nor root production (Fig. *c*). As cambial proliferation and production of roots are both induced in sunflower stem tissue by indole acetic acid, fragments of stem tissue were also cultured in the presence of pure penicillins. The reactions of such stem fragments to different concentrations of these substances as well as to commercial penicillin and indole acetic acid are given in the accompanying table.

RESPONSE OF FRAGMENTS OF SUNFLOWER STEM TISSUE CULTURED FOR FOUR WEEKS IN THE PRESENCE OF PENICILLIN OR INDOLE ACETIC ACID

Substance	Concentration		
	10^{-5}	10^{-7}	10^{-9}
Indole acetic acid	*CP* 0/10*	*CP* 10/10	7/10
Commercial penicillin	*CP* 10/10	1/10	0/10
Penicillin *X*	5/10	7/9	0/10
Penicillin *F*	0/10	0/10	9/10
Penicillin *G*	9/10	6/10	10/10
Penicillin *K*	0/10	0/10	0/10
Control, on plain sucrose agar	0/10		

* The fractions refer to the number of stem fragments in each group which produced roots. *CP* = cambial proliferation.

The effect of commercial penicillin on these stem fragments can be attributed with a fair degree of certainty to indole acetic acid, which is known to be produced by *Penicillium notatum* (O. Wintersteiner, personal communication). According to this assay, it appears that indole acetic acid was present in the penicillin in a concentration of about 1 per cent. The root-forming capacity of penicillins *G* and *X* almost certainly resided in these substances themselves. Penicillin *K* had no effect on the growth of the stem fragments. The results obtained with penicillin *F* are doubtful. None of these substances seemed to have any inhibiting effect on the growth of these plant tissues. Streptomycin, which was tested at the same time, also had no inhibiting effects and was without influence on root formation.

Pure penicillins were kindly made available by the following organisations: penicillins *G* and *K*, Squibb Institute, New Brunswick, N.J.; penicillin *X*, Food and Drug Administration, Washington, D.C.; and penicillin *F*, Upjohn Co., Kalamazoo, Mich.

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Oxidation of Tryptophane by Homogenized $a+a+$ and aa *Ephestia* Tissue

It has been shown previously that in the flour moth, *Ephestia Kuhniella*, the gene *a* in homozygous condition causes lack of kynurenin and consequently a deficiency in the eye pigments depending on the presence of kynurenin[1]. Since kynurenin is derived from tryptophane by oxidation, it is assumed that the oxidation of tryptophane to kynurenin is inhibited in *aa* animals. This is confirmed by the fact that an increased amount of tryptophane is found in the proteins of *aa* animals[2,3].

It had been suggested that in *aa* tissues the enzymes necessary for the formation of kynurenin from tryptophane may be missing or less active than in $a+a+$ tissues. The experiments described below were done in order to test this possibility. A number of full-grown *Ephestia* larvæ from closely inbred $a+a+$ and *aa* strains were weighed and ground up in a mortar in Ringer solution isotonic for *Ephestia*[4], buffered by an $m/50$ phosphate buffer at pH 6·8. The average net weight for a single larva was found to be 32·6 ± 5·4 mgm. in $a+a+$ and 22·4 ± 5·6 mgm. in *aa*.

The brei resulting from grinding the larvæ in a mortar was homogenized in a homogenizer (Potter and Elvehjem[5]) driven by a motor. Aliquots of 1 c.c. of the resulting suspension, corresponding to 46·7–110·2 mgm. net weight of larval material, were pipetted into the vessels of a Fenn type respirometer, and the oxygen uptake for one hour at 25·5° C. measured. In the experimental vessels Ringer solution containing 0·05 and 0·2 per cent tryptophane was used. The results of these measurements are given in the accompanying table.

OXYGEN CONSUMPTION OF HOMOGENIZED $a+a+$ AND *aa* LARVÆ ($MM.^3$/GM./HR. ± STANDARD ERROR)

	$a+a+$	*aa*
Control	110·7 ± 2·6	102·5 ± 2·0
0·05% tryptophane	132·5 ± 4·7	123·8 ± 5·7
0·2% tryptophane	162·4 ± 5·7	161·8 ± 5·5

The data indicate a somewhat higher oxygen consumption in $a+a+$ than in *aa* in the controls. This difference is probably significant ($t = 2·50$, $N = 37$, $P < 0·02$). This may be connected with the higher viability and speed of development characteristic for $a+a+$ *Ephestia*[6].

Addition of tryptophane caused an increase in respiration both in $a+a+$ and in *aa* material. The increase is significant at the 1 per cent level both at 0·05 per cent tryptophane, as compared with the controls, and at 0·2 per cent tryptophane, as compared with 0·05 per cent tryptophane. This indicates that in the range of concentrations investigated, the increase in oxygen consumption was limited by the amount of tryptophane present.

No significant differences between $a+a+$ and *aa* material were found with 0·05 and 0·2 per cent tryptophane. This indicates that *aa* material is as able as $a+a+$ material to oxidize tryptophane.

In the experimental vessels, both in $a+a+$ and in *aa* a dark precipitate developed during the experiments. This precipitate was either absent or very weak in the controls. It was insoluble in water, alcohol, ether and acetone, soluble with difficulty in acidified alcohol and weak alkali, but easily soluble in concentrated formic acid. This solubility behaviour is characteristic of ommochromes, the insect pigments formed from kynurenin[7,8].

These results indicate that *aa* material is as well able to oxidize tryptophane as $a+a+$. It is suggested, furthermore, that *aa* material is able to transform it into kynurenin, the precursor of the ommochrome pigments. If the oxidation of tryptophane to kynurenin is dependent on an enzyme analogous to the tryptophane pyrrholase catalysing the same reaction in mammals[9], the results seem to suggest that this enzyme is present and active in *aa* as well as in $a+a+$ cells.

The situation in *aa Ephestia* would therefore be that tryptophane is present and that the enzyme necessary for its oxidation to kynurenin is also present. A similar condition has been found for body-colour mutants in *Drosophila*, where changes in the amount of melanin formed were not accompanied by a concomitant change in either tyrosinase or tyrosine present[10,11]. It seems justifiable to conclude that in cases of this type the action of the enzyme on the substrate is inhibited.

I am indebted to Dr. David R. Goddard, of the University of Rochester, for valuable aid and advice.

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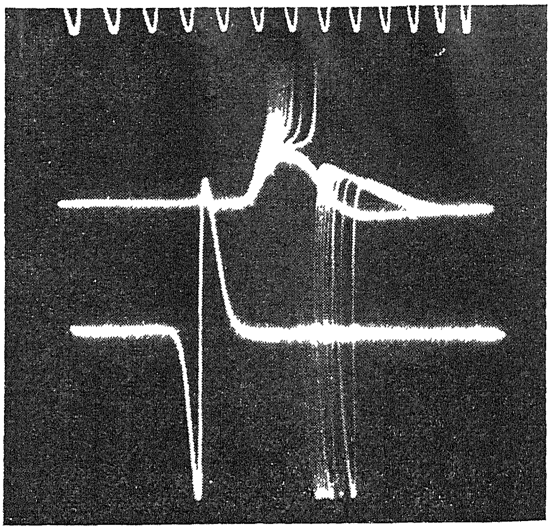
A Preparation for the Physiological Study of the Unit Synapse

Present concepts of synaptic activity are based on direct recording of electrical signs in a small number of preparations. The closest approximations to analysis of the unit synapse have been made with the artificial synapse formed by two isolated giant axons in contact (ephapse of Arvanitaki[1]) and the isolated neuromuscular junction[2]. Several true synapses among invertebrates offer promise as favourable material for recording from the single synapse, for example, the preparations of Pumphrey and Rawdon-Smith[3] from the cockroach and of Prosser[4] from the crayfish abdominal ganglion. The present communication directs attention to the possibilities of another preparation, from the stellate ganglion of a cephalopod, which appears to offer unique advantages.

Young[5] has described the remarkable giant synapse in this ganglion in squid. Thick terminal branches of a single preganglionic fibre (second order giant fibre) from the brain make contact with about ten third order giant fibres which originate in the ganglion and are



POTENTIALS FROM STELLATE GANGLION OF *Loligo pealii* PREGANGLIONIC NERVE IS STIMULATED AT 30 PER SECOND LOWER TRACE OF DOUBLE BEAM OSCILLOGRAPH PICKED UP AT JUNCTION OF PREGANGLIONIC NERVE WITH GANGLION, UPPER TRACE FROM ORIGIN OF POSTGANGLIONIC NERVE MULTIPLE EXPOSURE OF SUPERIMPOSED STIMULUS-TRIGGERED SWEEPS ONSET OF FATIGUE SHOWING ALL OR NONE SPIKES AND FALLING LOCAL RESPONSE TIME = 0 5 M SEC

distributed, one in each postganglionic stellar nerve, to the mantle musculature At the region of contact the presynaptic fibre and postsynaptic fibre, each 25–100 μ in diameter, lie side by side for 800 μ, making connexions through small holes in their sheaths, by many short collaterals Cell bodies or dendrites are not involved

In *Loligo pealii* a preparation is easily isolated consisting of preganglionic nerve (mantle connective with fin nerve removed), stellate ganglion and the last stellar nerve Single shocks at low intensity delivered to the preganglionic nerve excite a single giant fibre therein and, after a delay in the ganglion of about 1 2 m sec. (23° C), the giant fibres in the stellar nerves This delay does not include any significant conduction time in fine tapering terminals Transmission is all or none and one to one; the synapse can follow upwards of four hundred impulses per second for short periods Increasing shock intensity brings in many smaller preganglionic fibres (including presumably Young's accessory second order giant), some lagging scarcely at all behind the presynaptic giant, but does not alter transmission noticeably. Antidromic impulses are not transmitted from postsynaptic to presynaptic fibre. Transmission is easily blocked by fatigue and for long periods can be kept at any desired level by maintained stimulation of the prefibre at controlled frequency Thus a certain preparation, once fatigued, could be kept in a non-transmitting state by stimulation at 30 per sec. while dropping the frequency to 25 per sec permitted transmission. Untransmitted impulses continue to exert an effect, maintaining fatigue of the junction, apparently by acting on the postsynaptic unit.

The preparation permits recording not only of single presynaptic and postsynaptic fibres but also of unit synaptic potentials (local activity of the unit synapse, the non-propagated, graded response corresponding to end-plate potential in muscle) A large electrode (0 2 mm. platinum wire) on the ganglion may pick up several of the ten or so junctions, but they are activated by the same presynaptic fibre, are well synchronized and rarely behave independently. Micro-electrode recording gives the same picture as large electrodes in situations studied so far. The synaptic potential detectable with macro-electrodes may be more than 300 μV., rise to its peak in about 0 6 m.sec and fall to a third in less than 1 m sec In fatigue the local response may suffer no change in latency but falls greatly in height, the propagated spike arising later and later, often apparently from the falling phase of local response (cf Hodgkin[6]) By graded stimulation directly on the ganglion the synaptic potential may be graded Its absolute refractory period is about 1 m sec. and is followed by a relatively refractory period in which at first very small potentials are elicited, later increasingly large ones Facilitation has been recorded in the fatigued preparation when the first stimulus of a pair elicits only local response whereas the second, if it follows within a critical interval during the relatively refractory period of local response, may result in a propagated impulse.

The general properties of the preparation are strikingly similar to those of the ephapse of Arvanitaki[1] and, with respect to the local response, those of the peripheral nerve fibre[6]

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Adrenal Cortical Hormone and Pigmentation

THE association between the adrenal glands and pathological pigmentation is well established, and it has been suggested that these glands may also control the physiological process[1,2,3] The influence of sodium chloride on melanin formation *in vitro* has been demonstrated[4], and it follows that if physiological pigmentation is controlled by this mechanism, then deeply pigmented animals should have a low chloride concentration To confirm this the concentration of chloride in the blood of agouti and black mice has been investigated, using a cross between the *CBA* (Strong) and *C57* (Little) strains which segregates for these colours

Much difficulty has been experienced in obtaining reliable estimations from the small quantities of serum available Even by draining the inferior vena cava it has not been found possible to guarantee more than 0 2 c c of serum, and all estimations have been made on this quantity The method used has been that of Schales and Schales[5], but with only 0 2 c.c of serum the end-point is not certain To eliminate errors from this source, a photometric apparatus has been constructed, the electrical circuit being taken directly from that described by Needham[6] Illumination is by a 40-watt pearl bulb housed in a light-tight tin, in which are two ½-in holes opposite to and at the height of the centres of the selenium cells No lenses are used, but two movable screens with ⅜-in holes are placed immediately in front of the selenium cells, to act as baffles The whole is enclosed in a light-tight box, of which the ends can be opened The apparatus is completed by a microburette mounted on a movable arm so arranged that the nozzle can either be brought to a position immediately in front of one of the selenium cells when the end of the box is open, or removed to such a position that the box may be closed. Galvanometer readings are made only with the box closed

Estimations are made on protein-free filtrates, prepared by adding to 0 2 c c. serum, 11 c c water and 0 5 c c of each of the Folin-Wu reagents. 10 c c of the filtrate are placed in an optical cell, with 0 06 c c indicator The cell is placed immediately beneath the microburette between a movable screen and the selenium cell The resistance is varied so that more current is fed to the galvanometer from this selenium cell than from the other, the difference being accurately adjusted to one degree on the galvanometer scale Titration is carried out until sufficient colour is developed in the optical cell to balance the circuit and return the galvanometer needle to zero This is regarded as the end-point It is, of course, arbitrary, but gives constant results within the limits examined, that is, 100–150 milli-equivalents per litre of chloride The calculation is made as in the original method, with the necessary adjustment for the quantity of serum used In this way it has been found possible to estimate known solutions of sodium chloride using only 0 2 c c , with an error of 1 per cent

The mean value for agouti mice is 121 milliequivalents per litre, and for black 124 5 Estimation of the significance of the difference between these means gives $P = 0{\cdot}1$ for $n = 29$[7] Therefore, instead of the anticipated low concentration of chloride in black as compared with agouti mice, there is a small rise in this concentration, the difference however, not being significant There is thus no evidence of any difference in adrenal cortical function between agouti and black mice as judged by the concentration of chloride in serum As these results are considered accurate to within 1 per cent, and a difference of very much more than 1 per cent in the chloride concentration is necessary to affect melanin formation[3], it can definitely be stated that if physiological pigmentation in the mouse is controlled by the adrenal glands, the action is not through the chloride balance hormone of the cortex.

I have pleasure in acknowledging my indebtedness to Mr A L. Bacharach for the nucleus of the mouse colony, and to Mr D C Price for much valuable advice and help with the electrical part of the apparatus The work has been carried out with the aid of a grant from the Leverhulme Research Fellowships

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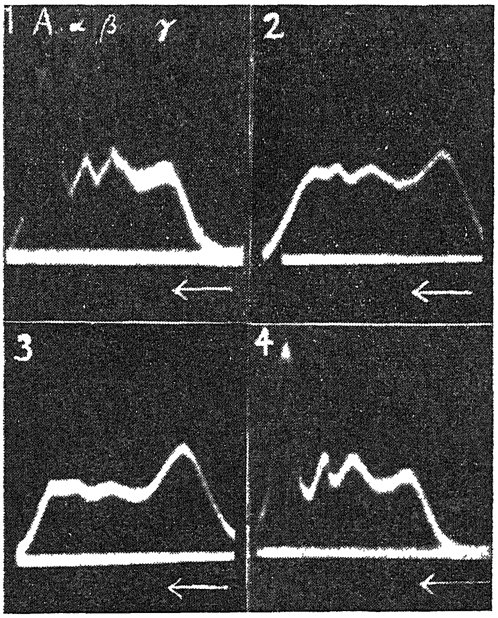
Action of Pepsin on Serum Proteins as Measured by Electrophoresis

SINCE the beginning of this year, we have had the first apparatus for electrophoresis (Tiselius–Philpott–Svensson), which has been wholly built in Switzerland (Strubin and Co . Basle) Our main object is to study the physio-pathological alterations in the blood proteins during disease. In addition, we aimed at studying problems of general biological interest

Thus we endeavoured to illustrate the action of pepsin (Fairchild) on serum proteins by taking electrophoretic patterns of the remaining proteins at different stages of the digestion In order to measure the undigested remainder of the serum proteins we used the nephelometric method, as developed by Krijgsman[1]. In this method the protein concentration is proportional to the turbidity which is produced with sulphosalicylic acid in a strongly acid solution There is no accurate proportion between digested protein and the increase of the degradation products Therefore a method measuring the last-named products would not be exact in our case As buffer system we used veronal/sodium – sodium/acetate/hydrochloric acid (Michaelis), mostly used for electrophoresis. During the peptic digestion the pH was kept at 5 1, the temperature at 37° C , and the pepsin-protein ratio was 1 · 9. In order to stop the reaction, the pH was brought to 7·9 and the solution dialysed against buffer solution of an ionic strength of



0 1 for four days at 2° C By this method the protein solution remains perfectly clear, a fact which, of course, is all-important when distinct patterns are wanted Electrophoresis was carried out at 2° C, with a potential gradient of 3 74 volts per cm for 8,520 sec All the patterns show 'descending boundaries', and the migration takes place from the right side to the left The basic line has been reduced according to Wiedemann's method[2].

		Electrophoretic concentrations (gm per cent)					
Pattern	Total protein (gm %)	Albumin	α	β	γ_1	γ_2	Albumin / Globulin
1	6 5	2 21	0 88	1 21	0 40	1 90	0 54
2	3 9	0 89	0 62	0 81	0 39	1 19	0 29
3	2 9	0 54	0 41	0 50	0 30	1 15	0 23
4	6 1	2 19	0 86	1 12	0 38	1 55	0 35

The accompanying table shows that peptic digestion primarily attacks the albumin, whereas the various globulin fractions are degraded in a much less degree Our method of repeated electrophoresis gives a good illustration of the kinetics of proteolytic action Thus electrophoresis can serve as control of the various factors (that is, pepsin-protein ratio, pH-value, temperature and time) that govern the purification of antitoxic sera by means of enzyme digestion Further studies will show whether antibodies contained in the γ-fraction have an inactivating effect (compare Sevag[3]) on pepsin, or if they are simply degraded more slowly under otherwise optimal conditions (Pope[4]), Abderhalden[5]

Pattern 4, which was produced after dialysis of the serum in a small bag of parchment paper and eliminating the precipitated proteins after 48 hours by centrifuging, shows some decrease of the β- and γ-globulins, whereas the more lyophylic albumin and α-globulin remain almost unchanged. It forms thus a good contrast with the action of pepsin on the same serum proteins, in which the albumin globulin ratio is lowered.

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Sulphonamides and the Thyroid Gland

IT has been known since 1941 that sulphonamides influence the thyroid gland. MacKenzie, MacKenzie and MacCollum[1] note that rats on a purified diet containing 1–2 per cent of sulphanilylguanidine show hypertrophy of the thyroid gland. The action is not influenced by yeast, p-aminobenzoic acid, or excess of iodine. Somewhat later[2], sulphadiazine, sulphathiazole, sulphapyridine and sulphanilamide were found to produce a similar effect. Basal metabolism is lowered by any sulphonamide, and sulphanilamide is the least active one. Taurog, Chaikoff and Franklin[3] showed that sulphonamides and similar products inhibit the formation of diiodotyrosine and thyroxin by living tissue slices of thyroid *in vitro*, in presence of radioactive inorganic iodine.

Hitherto the connexion has not been seen between the action of sulphonamides on the thyroid gland and their bacteriostatic power *in vivo* In a theory I have put forward[4], I suggested that the bacteriostatic action of sulphonamides is increased by the association of a goitrogenic molecule with their own molecule. Experiments carried out jointly with Dr Antonio Oriol and Dr Antonio Esteve confirmed this point of view

A goitrogenic compound, such as methylthiouracil, alone has no bacteriostatic power in mice, on the other hand, a mere equimolecular mixture of methylthiouracil and sulphanilamide has, on mice infected by pneumococci, the same protecting power as sulphathiazole When the proportion of methylthiouracil is decreased, the protecting power falls proportionally.

Increase of bacteriostatic power by the addition of a goitrogenic compound to a sulphonamide can be made evident by separate applications of the two compounds. Thus, if the methylthiouracil is given to infected mice 8 hours after giving them the sulphanilamide, still 60 per cent of the animals are protected, whereas sulphanilamide alone protects only 20 per cent

Another series of experiments was carried out with thyroidectomized mice As soon as the animals recover from the post-operatory effects, they react against medication by sulphathiazole in exactly the same way as against sulphanilamide. Sulphathiazole or sulphanilamide equally protect 33 per cent of the thyroidectomized mice Hence there will be no increase in the bacteriostatic power of sulphonamides when the thyroid gland is missing.

Several theories have been proposed to explain the action of sulphonamides and similar compounds on the thyroid gland Astwood[5], the discoverer of the goitrogenic compounds, says that the aromatic amines, by their resemblance with tyrosine, interfere with thyroxin formation, by taking the iodine necessary for it This explanation can be applied only to definite cases, especially to the case of p-aminobenzoic acid, which behaves as a goitrogenic compound after several months of massive doses The immediate action of other goitrogenic compounds, made very clear by the investigations of Nogales, Tarrida and Castello[6], cannot be explained by that long process of substitution of the hormone

Gyorgyi *et al*[7] impute the goitrogenic power of sulphonamides and of p-aminobenzoic acid to their anti-oxidizing properties As according to our experiments the goitrogenic character is closely connected in sulphonamides with the bacteriostatic one, anti-oxidizing properties would decrease it Further, it is known that sulphonamides act better in presence of oxidizers such as azochloramide (Daquin's liquor or perhydrol) · and it is known, on the other hand, that the anti-sulphonamidic power of p-aminobenzoic acid and similar compounds is based on their anti-oxidizing properties[4] The weak bacteriostatic power of sulphanilyl-thiourea is well explained by the anti-oxidizing properties of thiourea

Taurog *et al.*[3] believe that an inhibition of mineral iodine absorption explains the goitrogenic action of sulphonamides However, those authors' experiments demonstrate that the power of inhibiting the synthesis of the hormone has nothing to do with the bacteriostatic properties Thus metanilamide inhibits the hormone synthesis more than sulphanilamide, and *meta*-aminobenzoic acid as much as *para*-aminobenzoic acid As, on the other hand, that theory does not explain the immediate decrease of basal metabolism after the administration of goitrogenic compounds[6], we have to consider the mechanism of the inhibition of the hormone synthesis as a quite independent one of the mechanisms of goitrogenic and bacteriostatic actions

In our opinion sulphonamides act on the enzymatic system necessary for the formation of the thyroid hormone and also on that for the growth of bacteria This effect, as I have already shown[4], is followed when the sulphonamide contains a goitrogenic element in its molecule, by direct action on thyroxin wherever it happens to be That action, which consists, according to Roblin[8], in a transformation of organic iodine into mineral iodine, is accompanied, in the case of thiouracils and aminothiazoles, by the formation of disulphides, and in the case of aminopyridines and aminopyrimidines, by the formation of the corresponding dipyridyles or dipyrimidyles As regards the *in vitro* activity of sulphonamides, it is known that the differences of bacteriostatic power between sulphonamides are weaker than *in vivo* Roblin's theory of the influence of physical properties can be applied in that case.

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Browsing of *Patella*

THE food of *Patella vulgata*, so far as we know at present, consists mainly of small Algæ including diatoms[1] which it scrapes from the rocks by means of its radula, but it will also eat larger plants[2]. Orton[3] included a note on *Patella* eating food-paths in green Algæ on piers. Moore and Sproston[4] noted that the growth of Algæ was limited by the browsing of limpets, and Moore[5] has estimated their food requirements from observations on individuals clearing an algal felt. The importance of this browsing habit in connexion with foreshore ecology does not, however, appear to have been sufficiently realized. The following experiment illustrates this importance in striking fashion.

In connexion with work[6] on the rate of growth of *Patella* an area 5 m. by 5 m. at Port St. Mary, Isle of Man, was cleared completely of limpets in January 1946. The situation was on flat limestone rock somewhat below mean sea-level. There was no growth of Algæ on the cleared square or on the surrounding rock, except in a few small pools and crevices. Most of the area was covered with a dense population of *Balanus balanoides*, and the limpets were scattered fairly evenly over the rock but were rather less abundant among the barnacles. The total population of *Patella vulgata* in the square was 2,184 individuals, of which the majority ranged between 16 mm. and 30 mm. in shell-length.

In April it was seen that various species of Algæ were commencing to establish themselves in the cleared area. These grew until, in June, they had formed a fairly thick felt covering most of the square. The most important constituent of the felt was *Enteromorpha compressa*, with some *Porphyra umbilicalis* and *Ulva linza*. A number of plants of *Fucus vesiculosus* were scattered among the felt. At the same time about a hundred limpets had migrated into the square from the outside and prevented the algal felt from covering its outer edges. It was distinctly noticeable that there was no growth of Algæ on the rock outside the square, though this was in every way similar except for the presence of limpets. The shells of the limpets themselves, however, were covered with Algæ. In July the algal felt was decreasing in extent as more limpets moved into the area and started to browse upon it. The plants of *Fucus vesiculosus*, however, were growing strongly, and by August 6 were well established, apparently having been protected during their early stages by the felt of *Enteromorpha*, which by that date had largely disappeared. The population of *Patella vulgata* in the square was then 324 individuals which had moved in from the surrounding rock, and in addition 499 of the present year's spat.

Confirmation of the growth of Algæ in the absence of limpets comes from Eslick. In 1937 he cleared an area 2 m. by 2½ m. at Port St. Mary of its *Patella* population[7]. The tidal-level was about the same. He informs me that during the following year he observed this area and found it entirely covered with a strong growth of *Fucus vesiculosus*. In this case the area was sharply outlined, indicating that there had been little movement by the limpets on the surrounding rock. The difference would appear to be due to the fact that the surface of the rock is very much rougher in the location where Eslick worked than at the site of the 1946 experiment, and that this factor limits the movements of *Patella*.

The conclusion to be drawn is that *Patella vulgata*, by browsing over the rocks, removes the Algæ which settle before they can become established, much as goats prevent the growth of trees. In the case of *Fucus*, once it reaches a certain size it is not eaten by the limpets. It is not too much to suppose that in the absence of *Patella* the whole of the foreshore where it is suitable for their settlement would be thickly covered with Algæ.

Experiments are continuing on a larger scale.

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Gene Recombination in *Escherichia coli*

ANALYSIS of mixed cultures of nutritional mutants has revealed the presence of new types which strongly suggest the occurrence of a sexual process in the bacterium, *Escherichia coli*.

The mutants consist of strains which differ from their parent wild type, strain *K*-12, in lacking the ability to synthesize growth-factors. As a result of these deficiencies they will only grow in media supplemented with their specific nutritional requirements. In these mutants single nutritional requirements are established at single mutational steps under the influence of *X*-ray or ultra-violet[1,2]. By successive treatments, strains with several requirements have been obtained.

In the recombination studies here reported, two triple mutants have been used: *Y*-10, requiring threonine, leucine and thiamin, and *Y*-24, requiring biotin, phenylalanine and cystine. These strains were grown in mixed culture in 'Bacto' yeast-beef broth. When fully grown, the cells were washed with sterile water and inoculated heavily into synthetic agar medium, to which various supplements had been added to allow the growth of colonies of various nutritional types. This procedure readily allows the detection of very small numbers of cell types different from the parental forms.

The only new types found in 'pure' cultures of the individual mutants were occasional forms which had reverted for a single factor, giving strains which required only two of the original three substances. In mixed cultures, however, a variety of types has been found. These include wild-type strains with no growth-factor deficiencies and single mutant types requiring only thiamin or phenylalanine. In addition, double requirement types have been obtained, including strains deficient in the syntheses of biotin and leucine, biotin and threonine, and biotin and thiamin respectively. The wild-type strains have been studied most intensively, and several independent lines of evidence have indicated their stability and homogeneity.

In other experiments, using the triple mutants mentioned, except that one was resistant to the coli phage *T1* (obtained by the procedure of Luria and Delbrück[3]), nutritionally wild-type strains were found both in sensitive and in resistant categories. Similarly, recombinations between biochemical requirements and phage resistance have frequently been found.

These types can most reasonably be interpreted as instances of the assortment of genes in new combinations. In order that various genes may have the opportunity to recombine, a cell fusion would be required. The only apparent alternative to this interpretation would be the occurrence in the medium of transforming factors capable of inducing the mutation of genes, bilaterally, both to and from the wild condition. Attempts at the induction of transformations in single cultures by the use of sterile filtrates have been unsuccessful.

The fusion presumably occurs only rarely, since in the cultures investigated only one cell in a million can be classified as a recombination type. The hypothetical zygote has not been detected cytologically.

These experiments imply the occurrence of a sexual process in the bacterium *Escherichia coli*; they will be reported in more detail elsewhere.

This work was supported in part by a grant from the Jane Coffin Childs Memorial Fund for Medical Research.

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Assay of Toxic Effect of 'Gammexane' on Man and Animals

THE widespread use of the two new insecticides D.D.T. and 'Gammexane' (gamma isomer of benzene hexachloride) has led to considerable interest being taken in their possible toxic effect upon man and animals. In the case of D.D.T., a considerable literature is already available on this aspect, and both acute and chronic toxicity has been discussed by various authors. With regard to 'Gammexane', Cameron[1] has given some notes on its acute toxicity, and Slade[2] has reported the toxicity of the four benzene hexachloride isomers to rats, but little or no information is available as to the possibility either of chronic poisoning or of a cumulative effect.

The following experiments show that the possibility of any toxic effects from residues of 'Gammexane' dust on foodstuffs is extremely remote. The additions daily of 10, 20 and 30 mgm. per kgm. body-weight of pure 'Gammexane' in powder form to the diet of rats showed no effect whatsoever over a period of twenty-seven days. A longer experiment with much heavier dosages was carried out with benzene hexachloride containing 13 per cent of the gamma isomer. As most 'Gammexane' formulations are based on benzene hexachloride of this composition, the possibility of the other isomers having cumulative or chronic effects would also be demonstrated. The median lethal dose of this substance to rats is 1,250 mgm. per kgm. body-weight, and doses of 500 mgm. per kgm. body-weight were fed daily, mixed with the normal diet. The five rats treated were half-grown at the beginning of the test, and during the period of the experiment, namely, 57 days, their growth-rate was the same as that of untreated littermates. Appetites remained good, the daily ration being readily eaten, and no toxic symptoms of any kind were noted. At the end of the period the animals were killed and all organs found to be normal.

A similar experiment was carried out with pure D.D.T. powder, but a daily dose of 500 mgm. per kgm. body-weight gave rise to nervous symptoms within two days. A dose of 350 mgm. per kgm. body-weight was tolerated, but nervous symptoms occasionally appeared. Rats were kept under experiment for 48 days with this daily dose, but the growth-rate was less than in the control animals. No abnormalities were found in the internal organs.

These doses are much larger than generally reported in the literature, for example, Smith and Stohlman[3], but it should be noted that pure D.D.T. powder was used and not the commercial product, and that no oil was used to incorporate it in the diet.

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Active Aurora of September 28, 1946

THE aurora visible at Cambridge on the night of Saturday, September 28, showed considerable activity from 9 to 10 p.m. (B.S.T.). When most disturbed, there was a definite change of colour with increasing altitude, the lower portion being bright green, gradually changing to reddish from about altitude 30° up to and beyond the Pole.

The main structure was composed of several long triangular streamers in the red region, sharply terminated at their upper extremities, with broad bases gradually merging into the greenish lower portion.

A special feature was a long more rectilinear luminous streak, almost vertical, and extending from near γ *Ursæ majoris* to ε *Ursæ minoris*. This lasted for about ten seconds, and was decidedly not a meteor, although these were being looked for as forerunners of the expected stream from the Giacobini–Zinner Comet.

C. P. BUTLER

Cambridge.

CONRAD GESNER AND JOHANN JACOB SCHEUCHZER

ON September 7 there was celebrated the two hundredth anniversary of the founding of the Zurich Society of Natural Sciences. The Swiss Society of Natural Sciences held its 126th annual meeting at the same time, and the attendance of delegates from scientific societies in some thirty other countries conferred upon the Congress an international significance.

After addresses by the president, Prof. P. Niggli, professor of mineralogy and petrography in the University of Zurich, and by several of the foreign delegates, Prof. Hans Fischer, professor of pharmacology, delivered an address on the lives and works of two distinguished sons of Zurich, Conrad Gesner and Jacob Scheuchzer, each of whom occupied the position of town physician and greatly advanced the science of his time. The current issue of the Swiss scientific journal *Atlantis* contains not only some extracts from the correspondence of Gesner and Scheuchzer with their English friends but also a number of the remarkable illustrations which adorn Scheuchzer's principal work, "Physica Sacra".

Conrad Gesner (1516–65) was the pioneer of humanism in Zurich at the time of the great movements of the Renaissance and Reformation. That he was a man of immense industry is shown by his "Bibliotheca Universalis", published in 1545, a catalogue of all the writings in Hebrew, Greek and Latin which had appeared prior to that date. This great task completed, Gesner next set himself to describe, in systematic and scientific fashion, every known animal and plant. His "Historia Animalium", the first volume of which was issued in 1551, forms part of the basis of modern zoology, and contains a number of wood-cuts by Albrecht Durer. The botanical part of this wide scheme of research, "Historia Plantarum", was incomplete when Gesner died He was widely known for his writings, not merely in science but also in medicine, and he was held in high esteem as a physician.

Gesner's death from plague at the age of fifty-nine was indeed a great loss to science and medicine alike. Among the friends who mourned him was John Caius of Cambridge, who had written, at Gesner's request, his monograph on British dogs, "De Canibus Britanicis", and there were many others, since Gesner's house in Zurich was a meeting-place for scholars from all quarters.

A century later there was born another notable pioneer who became town physician of Zurich, Johann Jacob Scheuchzer (1672–1733). Scheuchzer lived at a time when the progress of science was greatly retarded by the rigid orthodoxy of the Church. Nevertheless, he was the first to describe, in a comprehensive and scientific fashion, the physical geography of the Swiss Alps, and he made many original observations on the meteorology, geology, botany and zoology of Switzerland. Those numerous observations, the results of many journeys in all parts of the country, led to the publication of his "Naturgeschichte des Schweitzerlandes" (1706–08) and "Herbarium Diluvianum" (1709), but his greatest work is contained in the four folio volumes entitled "Physica Sacra" (1731–35). They form a sort of commentary on the Old Testament such as could not fail to be accepted by the most bigoted churchmen of the day, without any sacrifice of scientific accuracy. Of outstanding interest are Scheuchzer's descriptions of fossil plants and animals and of *Homo diluvii testis* (the skull of a 'Rhinelander' man), the relics of an earlier flora and fauna which, he said, had been preserved beneath the waters of the Flood. The engravings which adorn this work are of great artistic merit. In medicine, Scheuchzer was less distinguished than Gesner, although in science he was a worthy follower—one of the leading pioneers in the wide field of natural philosophy.

DOUGLAS GUTHRIE

DENTAL CONDITION OF FIVE-YEAR-OLD ELEMENTARY SCHOOL CHILDREN

By DR. HELEN COUMOULOS
Girton College, Cambridge

A FIELD survey of the dental condition of more than 4,500 five-year-old elementary school children in various parts of England and of a few in Wales was undertaken during the years 1943–45. In the course of the survey the surface structure, the incidence and extent of caries, the 'healing' or arrest of the carious process and other conditions were carefully recorded on suitable charts. The standards used were those devised in 1927 by M. Mellanby[1].

The main results of this investigation are presented in the accompanying table, in the hope that they may be of interest to other workers and may serve as a basis for comparative study with future surveys of a similar nature. It must be emphasized, however, that when making such comparisons it is essential that the same standards should be used. Detailed analyses of some of the data obtained are in the press, and others will be published in the near future.

THE DECIDUOUS TEETH OF FIVE-YEAR-OLD ELEMENTARY SCHOOL CHILDREN 1943 TO 1945

Districts	Number of children inspected	Hypoplasia: Percentage of teeth with *M*-hypoplasia	Hypoplasia: Percentage of teeth with 'text-book' or *G*-hypoplasia*	Caries: Percentage of teeth carious	Caries: Percentage of carious teeth in which disease 'healed'
Urban					
London 1943	1870	66·8	2·5	30·1	11·7
London 1945	691	59·1	2·8	26·5	21·5
Sheffield 1944	507	74·9	4·0	30·5	10·6
Cambridge 1944	531	67·0	1·8	28·2	10·1
Caernarvon 1943	41	78·9	1·3	45·3	5·3
Total Urban	3640	66·9	2·6	29·4	12·9
Rural					
Cambridgeshire 1943	298	70·2	1·7	32·4	8·1
Oxfordshire 1944	353	63·6	3·1	28·4	12·5
Caernarvonshire 1943	29	71·0	1·3	38·2	12·6
Total Rural	680	66·7	2·3	30·6	10·6
High fluorine					
Maldon 1943	60	39·9	0·9	10·4	22·9
Maldon and district 1945	139	45·4	0·6	11·2	19·2
Grand total	4519	65·6	2·5	28·7	12·6

* Including a few teeth unclassified but with defects nearer to the *G*- than the *M*-type hypoplasia.

. Hypoplasia of all grades was found in 68·1 per cent of the teeth, 65 6 per cent having *M*-hypoplasia and *only* 2·5 per cent having the gross or 'text-book' form. Caries was present to a greater or less extent in 28·7 per cent of the teeth. The figures varied considerably in the different districts, but in general the higher the incidence of *M*-hypoplasia the greater the percentage of carious teeth, a fact which bears out the evidence given originally by M. Mellanby[1] to show that the worse the structure of a tooth, that is to say the greater its degree of *M*-hypoplasia, the greater its liability to be attacked by caries.

By far the best structure, the least incidence of caries and the greatest amount of 'healing' or arrest of the disease was found in Maldon. It has been inferred[2] that the comparative freedom from caries of the teeth in that district is due to the high concentration of fluorine (approximately 5 p p.m.) in the drinking water. This may be a fact, but if so the function of the fluorine is not yet known. In this investigation, as in that of King[3], the very low incidence of caries is definitely associated with a small amount of *M*-hypoplasia.

Two studies of five-year-old children attending London schools in 1943 [4] and 1945 [5] are of particular interest. The first was intended for comparison with a similar study made fourteen years before and showed that the dental condition in 1943 was much better from every point of view than that found in 1929. The 1945 survey showed that the improvement observed in 1943 had not only been maintained, but also exceeded. The structure of the teeth was better than in 1943, and the caries incidence was lower and the amount of arrest of the disease higher even than was expected from the improved structure, suggesting that some powerful beneficial influence had been at work during the post-eruptive as well as the developmental period.

A probable reason for this continued improvement in dental condition is indicated when the trend of the diet in Great Britain is considered. It is common knowledge that during recent years, and especially during the War, much attention has been paid to human nutrition in Great Britain. The increased consumption of the so-called protective foods, especially milk and cod-liver oil, by pregnant and nursing women and by infants, the war-time rationing of certain foods, the inclusion of vitamins D and A in margarine and the addition of calcium carbonate to flour, have helped to raise the dietary standard of some classes of the community and to make it more constant throughout the country. Incidentally, the diet has been enhanced in the main by those factors which have been shown by M. Mellanby and her colleagues[1,6] to be largely responsible for good tooth calcification and for the prevention or delay of the initiation and spread of caries after eruption of the teeth. It seems reasonable, therefore, to attribute the better dental condition of five-year-old London children in recent years to the improvement in the calcifying properties of the diet. The 1945 group, having received the dietary supplements mentioned above for longer periods than their predecessors of 1943, appeared to have benefited to an even greater extent, as is evident from the figures given in the table.

When the findings in this investigation are considered as a whole, in conjunction with the evidence that is available from animal experiments and other investigations on children, it would appear that the key to dental health lies in the ingestion and utilization by the body of a balanced diet rich in calcifying properties, especially vitamin D. It is not claimed that by these measures the elimination of dental caries would be attained, but it is felt that the prevalence of the disease would be considerably reduced.

Acknowledgments will be made when the full data are published.

[1] Mellanby, M., *Lancet*, **2**, 767 (1918) *Brit Dent J*, **44**, 1 (1923). *ibid*, **48**, 787, 1481 (1927) Med Res Coun Lond Spec. Rep. Ser, No 140 (1929), No 153 (1930); No. 191 (1934).

[2] Ainsworth, N. J, *Brit. Dent J*, **55**, 233 (1933).

[3] King, J D, *Dent Rcd.*, **64**, 102 (1940)

[4] Mellanby, M, and Coumoulos, H, *Brit Med. J*, **1**, 837 (1944).

[5] Coumoulos, H, and Mellanby, M, *Brit Med J*. (1946) (in the press).

[6] Mellanby, M., and Pattison, C L, *Brit Dent J*, **47**, 1045 (1926), *Brit Med J*, **2**, 1079 (1928); *ibid*, **1**, 507 (1932), Mellanby, M, Pattison, C L, and Proud, J W, *Brit Med J*, **2**, 354 (1924)

LIMITS OF EFFECTIVE HUMAN POWER

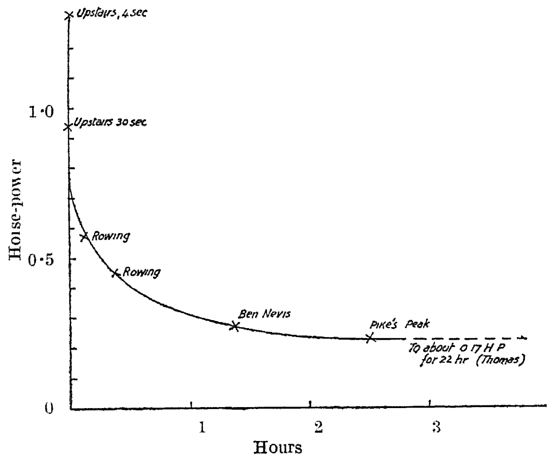
By P. J. H. UNNA

J. S. HALDANE and Yandell Henderson[1] have shown that heavy workers can maintain 0·13 effective horse-power on various tasks throughout an ordinary working day, and it has been pointed out[2] that this figure corresponds to the output when walking uphill at the moderately fast rate of 1,500 ft./hr., if gross weight, that is, with clothes and rucksack, is taken at 180 lb. The present purpose is to assemble corresponding figures for record power, according to the duration of the work. In general, they will be based on racing speeds uphill, for they afford an easy means of measurement of power. So does a cycle ergometer, but the recorded measurements scarcely apply, as they do not seem to have been made on specially selected athletes, though some suitable ones by rowing ergometer are available.

For quite short spells, the figures for running upstairs, given in Cathcart's table[3], will suffice. They work out at 1 32 h.p. for 4 sec., and 0·94 for 30 sec.; but his 0·44 h.p. for 3¾ min. has been kept up for a much longer time.

No further uphill figures for spells of less than an hour have been found. Thus the so-called guides' race at the Grasmere games was down as well as up, and the summit times do not seem to have been recorded; while the ascent of Glamaig from Sligachan Hotel in Skye by a Gurkha brought to Britain by Lord (then Mr. Martin) Conway[4] at the end of last century also fails for lack of essential data. The rise was just 2,500 ft., and the up and down times were 37 min. and 18 min.; but the course includes more than a mile of almost level ground to the foot of the hill. All that one can say is that his effective output of power in the steep part was probably in accordance with other records. One must therefore fall back on Yandell Henderson and Haggard's figures[5] for rowing, 0·45 h.p. for a 4-mile race in 22 min., and 0·57 h.p. for 1¼ miles in, say, 7½ min.

As to rather longer spells, the annual race from Fort William up Ben Nevis, and back again, also fails, not only because the summit times are not ascertainable, but also because two miles each way of level road were included. But one Ben Nevis race[6], on October 1, 1901, when the summit observatory was still operating, and which started at Achintee where the pony track begins to rise, and which ended at the top, showed remarkable endurance. The best times for the climb of 4,300 ft. were 1 hr. 8 min. 19 sec.



and 1 hr. 18 min. 44 sec., both made by observatory porters. So the winner's rate of ascent was 3,775 ft./hr., which would give an effective output of 0·27 h.p., even if his unrecorded weight is taken as only 10 stone gross.

Next in order of height, we have the ascent of Pike's Peak[7] from Manitou, a rise of 7,485 ft., by Mr. Robinson, the resident manager at the Summit House, in 2 hr. 31 min., or at 2,975 ft./hr. He weighed 156 lb., so his effective horse-power was 0·235. But for the fact that he was normally living at 14,000 ft., and was climbing below that level, this performance would not indicate his full power nearer sea-level.

Lastly, there is Mr. Eustace Thomas's walk[8] of May 29, 1920, in the Lake District, which included all the principal tops except those near Coniston. It was a switchback walk, undertaken at just over fifty years of age, and for which he trained on a vegetarian diet. It included ascents totalling 23,400 ft., and measured $58\frac{1}{2}$ miles. He covered the ground in 21·9 hr., and then, after resting for $2\frac{1}{4}$ hr., he went on, and completed 30,000 ft. of climbing within 30 hr. After going for $16\frac{1}{2}$ hr., he descended 2,400 ft. from Clough Head to Threlkeld at 6,450 ft./hr.; and then, after an hour's rest, climbed the 2.600 ft. up Saddleback at 2,400 ft./hr. His stripped weight was 171 lb., or, say, 175 lb. gross, giving an output of 0·21 h.p. But, so far as ascertainable from the recorded times, his uphill speed was, in general, rather less. Taking this and the effect of the hour's rest into account, it would be fairer to place his output at about 0·17 h.p.

When the various figures for power are plotted against duration, they lie on a smooth curve. If they were based on world records, like those for running, which, of course, does not result in any measurable effective power, the curve could be taken as indicating the highest outputs of which human beings are capable. But hill climbing is not suitable for organisation as a competitive sport, and, in any event, the figures used here may be far from comprehensive. So, while a curve based on the best possible performances would probably be similar in shape, it might lie at a rather higher level.

[1] *Nature*, **118**, 308 (1926)
[2] *Nature*, **118**, 481 (1926).
[3] Brit. Assoc Rep, 1922, p 167
[4] Scottish Mountaineering Club, Skye Guide, p 111.
[5] *Nature*, **118**, 308 (1926), and *Amer J Phys*, **38**, 431 (1909)
[6] *Scotsman*, Oct. 2, 1901.
[7] *Phil. Trans*, B, **203**, 192 (1913)
[8] *J. of Fell and Rock Climbing Club*, **4**, 202.

THE SMITHSONIAN INSTITUTION: REPORTS FOR 1944 AND 1945

THE report of the Secretary of the Smithsonian Institution and the financial report of the Executive Committee of the Board of Regents for the year ended June 30, 1944, contains, as usual, reports on the United States National Museum, the National Gallery of Art, the National Collection of Fine Arts and the Freer Gallery of Art, the Bureau of American Ethnology, the International Exchange Service, the National Zoological Park and the Astrophysical Observatory as well as on the Library and publications. The report refers to the abandonment of its normal peace-time research and exploration programme except for those projects planned to promote better cultural relations with other American republics or bearing on the war effort.

Among such war services mentioned in the report on the National Museum are the preparation by Dr. R. Kellogg, at the request of the National Research Council, of text, keys and distribution maps and illustrations of monkeys known to be susceptible to infection by malarial parasites; this information was required to aid in studies of malaria in man. Information relative to the distribution and identification of mammals involved in the transmission of diseases was also supplied, and nearly two hundred officers assigned to malaria survey or control units or similar activities received instructions or other help from personnel of the Division. Information on the disease-bearing insects of specific foreign areas was also supplied to the Division of Medical Intelligence of the Surgeon General's Office.

Use of the Library during the year was outstanding. In the Museum Library alone, some 520 requests for information were received from war agencies, many of which required a considerable amount of research to answer. The Library's large collection of duplicates was drawn upon by other departments of the Government, and through the Library of Congress the Smithsonian Library is co-operating with the American Library Association in the collection of material for aid to libraries in war areas, and has already contributed more than 20,000 periodicals from its own stock of duplicates.

The corresponding report for the year ended June 30, 1945, again refers to the suspension of a large part of the Institution's normal activities in research, exploration and publication, so that the staff could devote itself to aiding the work of the Armed Forces. The Institution's most useful war-time function has probably been the provision of technical information requested by the Army, Navy and war agencies. More than two thousand such requests were received during the first two years of war. Another war-time service was in the improvement of cultural relations with the other American republics, and the monumental Handbook of South American Indians made satisfactory progress under the guidance of Dr. J. H. Steward. Volumes 1 and 2 were in proof and Volumes 3 and 4 were sent to the printer towards the close of the year. The third part of a "Check List of the Coleopterous Insects of Mexico, Central America, the West Indies and South America", by Dr. R. E. Blackwelder, was published.

During the year many of the evacuated collections were returned to the Institution, the transfer being made without damage, in spite of many of the specimens being fragile and difficult to pack and to handle. The series of publications started early in the War to present authentic information on the peoples, geography, history and other features of war areas, entitled "War Background Studies", was completed during the year.

Among the outstanding publications of the year were C. G. Abbot's "Weather Predetermined by Solar Variation" in the Smithsonian Miscellaneous Collections; "Summary of the Collections of Amphibians made in Mexico under the Walter Rathbone Bacon Travelling Scholarship" by E. H. Taylor and H. M. Smith; and "Review of the Spider Monkeys" by R. Kellogg and E. A. Goldman in the *Proceedings of the National Museum*, and "Houses and House Use of the Sierra Tarascans" by R. L Beals, P. Carrasco and T. McCorkle, the first publication of the Institute of Social Anthropology.

Accessions to the Library totalled 4,844, bringing the total holdings to 918,460. A considerable number of valuable old works, some dating from the seventeenth and eighteenth centuries, were acquired by purchase during the year. The regular sending of consignments to the liberated countries of scientific publications had not been resumed by the International Exchange Service, and accumulations for France, Italy and Belgium were forwarded to the Office of War Information, and those for Sweden, Palestine and Egypt through the United States dispatch agent in New York.

INDUSTRIAL DEVELOPMENT IN EAST AFRICA

THE second annual report of the East African Industrial Research Board deals with activities for the year ending December 31, 1944, and stresses the need for competent survey of the industrial opportunities of the country and for planning for their orderly and rapid realization. The Board is concerned that its present war-time improvisations should be developed into a strong peace-time organisation, staffed with specialists in industrial science, economics and technology. Industrial research must now be judged by its contributions to the establishment of permanent competitive industry, and this means concentration on a smaller number of problems.

During 1944, the Industrial Management Board completed the installation at Nairobi of the old oil-pressing equipment removed from Merca in Somalia, and when production of cotton-seed oil started, the Industrial Research Board was called upon to assist in establishing processes and controlling products. Investigations were also started to assist in the improvement of locally produced soap, while a process has been developed for the preparation of motor fuel and other petroleum products by a method based on vapour-phase cracking of the vegetable oils contained in seeds. The seeds are heated to about 500°–550° C., when the oils are vaporized and partly cracked, the vapours passing to a cracking tube at 500°–650° C. at a pressure of about 100 lb. per sq. in. Fuel oils are recovered from the issuing gases by condensation and refined by conventional methods, a yield of about 26 gallons of motor spirit being obtained on the small plant per ton of cotton seed.

Investigations were also carried out to determine the physical constants of fibre board manufactured at Thika factory, Kenya, including expansion and expansion under changes of relative humidity, as well as on the water-proofing of soft fibre boards, surface treatment with a paraffin wax emulsion giving a water-resistant surface. Some attention has been given to the sizing of fibre boards to render them resistant to disintegration when wet, and some success was obtained by incorporating rubber latex, especially *Euphorbia* latex, in forming the board. The treatment of the boards to render them fire-resistant, and methods of extracting pyrethrum flowers, are other problems that have received attention. A pilot plant provided enough 4 per cent extract to meet essential needs. A new method involving extraction with the minimum amount of a non-volatile kerosene was developed, using a counter-current system and a rotary expeller; with this, some 2,500 gallons of 4 per cent extract were made available from some sixty tons of pyrethrum powder in military stores that would otherwise rapidly have become valueless. No substitutes examined gave promise of replacing pyrethrum by other insecticides not in similar demand for war purposes.

Vegetable fuels, the fire-proofing of fabrics and other materials, the protection of timber from insect damage, phosphatic fertilizers and ceramics are among other subjects engaging the attention of the Board, the latter having become the most important single item in the Board's research programme. Striking results have been obtained in making roofing tiles by incorporating certain vegetable fibres in the bodies used.

Included in this report are the reports of the Uganda Industrial Committee and of the Tanganyika Industrial Committee. The former committee functions both as a local agent and liaison for the East African Industrial Research Board, and as the body responsible to the Uganda Government for various industrial operations and undertakings. The hand-spinning and weaving centre at Kampala was continued until the latter part of the year, and construction of a pottery to provide essential articles to meet local demand was completed in February 1944, including a Chinese-type kiln. Under the Tanganyika Industrial Committee, a successor to the East African Substitutes Committee, research was carried out at Totaquina factory on the effect of fineness of grinding on efficiency of extraction, the course of the process of extraction of the alkaloids from the aqueous phase by oil, and the possibility of increasing the efficiency of extraction by adding amyl alcohol to the diesolene. At the Hone factory, experimental work on the production of different types of abrasive articles continued, and the first successful high-speed abrasive wheel to be made in East Africa was produced during the year.

AERIAL RECONNAISSANCE IN FORESTRY

THE aeroplane has been used to assist in forest fire protection for some years, and its use was brought to a high standard of efficiency in Canada before the First World War. It had also been more or less tentatively used by the Forest Department in India as an aid to describing the growing stock of forest areas for which working plans were under preparation. In the minds of many forest officers of experience, having regard to the considerable expense involved, the possibilities of its practical use were not regarded with any great enthusiasm.

The subject was referred to at the Sixth Sylvicultural Conference held in India in 1945. As is well known, a great deal of very accurate aerial photography was carried out in India and Burma during the Second World War by both the R.A.F. and the American Air Force. Mr. A. L. Griffith, of the Central Sylvicultural Forest Research Institute, discusses this matter in the *Indian Forester* (72, No. 5, May 1946. Civil and Military Gazette, Ltd., Lahore), stating that full use should be made of the work the air forces have done so far as Indian forests are concerned. As he remarks, many areas are difficult to get to and difficult to traverse on the ground, while others in addition are very unhealthy. Such areas are often not worth the time, labour and expense of a ground party. On the other hand, it has always been considered that accurate air surveys are expensive, difficult to organise and require a specially trained staff. The average forest officer has, therefore, hesitated to propose the use of an aeroplane for the purpose.

Mr. Griffith had occasion to make a fairly extensive tour of the Thar Desert of Sind. This is the south-western part of the Great Indian Desert and is some 10,000 square miles in area. It is bounded in the west by the Nara River, in the south by the Rann of Cutch, and in the north and east by other parts of the desert. It was desired to obtain information on the subject of the desert scrub growth in connexion with the Development of Sind plans. Some two hundred miles were travelled by camel, and the party saw a fair amount of the westerly edge of the area from Naukot in the south to Chhor in the north, penetrating some 30–40 miles into the desert. It was necessary to see the more southerly and easterly parts of the area, mainly towards Nagar Parkar on the edge of the Rann of Cutch, from which the general sand drift starts. This was done in a chartered Gipsy Moth aeroplane. Mr. Griffith found that he could take perfectly serviceable air photographs with an ordinary camera, though he had never tried to take an air photograph before. The experience gained and photographs have shown the value of this type of reconnaissance to the forest officer, alike for working plan purposes, erosion schemes, reconnaissance of new forest areas, and so forth.

PROPERTIES OF THE EARTH'S CRUSTAL LAYERS

BENO GUTENBERG has examined this problem in the light of a suggestion made by Zoeppritz in 1912 that changes with distance in amplitudes of observed seismic waves may give the required information. Three hundred earthquakes in southern California and several earthquakes recorded at Huancayo, Peru, and originating within 2,000 km. of this place have been used (*Amer. J. Sci.*, **243**, A, Daly Volume, 1945, pp. 285–312).

Gutenberg finds that the Mohorovičić discontinuity is at a depth of about 35–40 km. in the coastal areas of southern California, but deeper under mountain ranges. The velocity of Pn below it is close to 8·0 km./sec. At first, the velocities of both P and S increase with depth, probably at a rate similar to that in the upper layers, but the rate of increase falls off rapidly with increasing depth, resulting in a rapid decrease of the amplitudes of Pn and Sn with distance beyond $\Delta = 200$ km. Amplitudes of Pn and similarly of Sn in intermediate shocks without appreciable surface waves on records of shocks originating at various depths within a radius of about 2,000 km. from Huancayo, Peru, and recorded at the station there, confirm the previous results of Gutenberg and Richter (1939) concerning the relationship between the epicentral distances at which the amplitudes of Pn are very small, and the focal depth of the shocks.

These findings can be explained on the assumption that at a depth of about 80 km. the melting point of the material is reached. Immediately above that critical depth, the effect of temperature on the bulk modulus and on the coefficient of rigidity may approach or even surpass the effect of pressure. At the critical depth itself, there may be a slight sudden decrease of the wave velocity. Experimental data (Birch *et al.*, "Handbook of Physical Constants", *Geol. Soc. Amer. Spec. Papers*, No. 36 (1942), pp. 15, 28 and 59) are insufficient to decide which decrease is larger at the melting point, that of the elastic constants or that of the density. At greater depth, the effect of the temperature on the bulk modulus and the coefficient of rigidity becomes more and more insignificant. Whereas above the critical depth, a minimum stress of the order of 10^9 dynes/cm.^{2} (the strength) is required to start plastic flow, below this depth the strength is much smaller, and the plastic flow is controlled mainly by the plasticity of the material.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Sunday, October 20—Friday, October 25

BRITISH MYCOLOGICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W 1)—Jubilee Meeting.

Wednesday, October 23

At 10 a.m.—Fiftieth Annual Meeting, at 11 a m.—Dr. J. Ramsbottom "Mycology Then and Now" (Presidential Address), at 2 p m.—"Medical Mycology. Mould Products".

Thursday, October 24

At 10 a m—"Seed-borne Fungi"; at 2 p m.—"Mycorrhiza Soil Fungi"

Friday, October 25

At 10 a.m—"Growth Factor Requirements of Fungi"; at 2 p m—"Taxonomy".

Monday, October 21

CHEMICAL SOCIETY (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY, and the BUREAU OF ABSTRACTS, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 6 p.m—Dr. G Malcolm Dyson: "A New Notation for Organic Chemistry".

Tuesday, October 22

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 30 p m.—Prof. R. E. Peierls. "Fundamental Particles".

Wednesday, October 23

RESEARCH DEFENCE SOCIETY (at Manson House, Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W 1), at 3 15 p m—Annual General Meeting. Prof. N. Hamilton Fairley. "War-time Research in Malaria and other Tropical Diseases of Military Significance" (Fifteenth Stephen Paget Memorial Lecture).

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at Faraday Building, 9th Floor, South Block, Knightrider Street, London, E C 4), at 5 p m—Mr J. Eccles: "Buildings for Telecommunications—Some Views and Suggestions"

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 6 p m—Mr. H F. Pritchard "The Problems of Blind Landing"

ROYAL STATISTICAL SOCIETY, BIRMINGHAM AND DISTRICT GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham 2), at 6 30 p m—Mr A. S. Wharton: "Market Research".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p.m.—Discussion on "Sweet Confectionery" (Mr. D. W. Grover: "The Keeping Properties of Confectionery as Influenced by its Water-Vapour Pressure"; Mr. H. F Bamford and Mr. H. M. Mason: "Estimation of the Fineness of Grinding of Chocolate").

BRITISH ASSOCIATION OF CHEMISTS, LONDON SECTION (at Gas Industry House, 1 Grosvenor Place, London, S W 1), at 7 p m —Mr D. Matheson "Fire and Explosion 2, Methods of Minimising the Results of Explosion".

Thursday, October 24

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p m —Scientific Papers

CHEMICAL SOCIETY (joint meeting with the SHEFFIELD UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Sheffield), at 5 30 p m —Prof A R Todd, F R S "A Synthetic Approach to the Nucleotides".

LEEDS METALLURGICAL SOCIETY (in the Chemistry Lecture Theatre, The University, Leeds), at 7 p m —Mr R H Bomback Photography and Metallurgy" *

ROYAL INSTITUTE OF CHEMISTRY, TEES-SIDE SECTION (in the Main Hall, William Newton School, Junction Road, Norton-on-Tees), at 7 15 p m —Sir Jack Drummond, F R S 'Experiences at the Ministry of Food during the War"

CHEMICAL SOCIETY (joint meeting with the MANCHESTER UNIVERSITY CHEMICAL SOCIETY and the LOCAL SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Department, The University, Manchester), at 7 30 p m —Prof Wilson Baker, F R S 'The Chemistry of Penicillin".

Friday, October 25

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W 1), at 2 30 p m —Discussion on "Health Problems in Germany" (to be opened by Brigadier Tom Kennedy)

CHEMICAL SOCIETY (joint meeting with the ALCHEMISTS' CLUB and the ANDERSONIAN CHEMICAL SOCIETY, at the Royal Technical College, Glasgow), at 3 45 p m —Prof R A Morton Evidence Concerning the Mode of Action of Vitamins"

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4 30 p m —Geophysical Discussion on "The Burton-on-Trent Explosion"

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m. —Mr L J Matthews. Inaugural Address as Chairman

CHEMICAL SOCIETY (joint meeting with the LOCAL SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY, at Marischal College, Aberdeen) — Prof. G D Preston: 'Microscopy with Electrons and X-Rays"

Saturday, October 26

ROYAL INSTITUTE OF CHEMISTRY (in the Letters Lecture Theatre, The University, Reading), at 2 30 p.m —"Water Supplies" (Prof H. L. Hawkins, F R.S., "The Geology of Water Supplies", Mr W Gordon Carey "The Chemistry and Bacteriology of Water Supplies").*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

PROGRESS AND MATERIALS SUPERINTENDENT at the Board's Chiswick Works—The Chief Staff and Welfare Officer (E R /E 260), London Passenger Transport Board, 55 Broadway, London, S W 1 (October 26)

LECTURER IN PHARMACOLOGY—The Secretary and Registrar, The University, Bristol (October 26)

LECTURER IN PHYSICS, and a LECTURER IN STRUCTURAL ENGINEERING, at the South-West Essex Technical College and School of Art —The Chief Education Officer, County Offices Chelmsford (October 26)

ASSISTANT LECTURER IN TEXTILE CHEMISTRY, and an ASSISTANT LECTURER IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (October 28)

HEAD OF THE DEPARTMENT OF INDUSTRIAL ADMINISTRATION—The Registrar, Birmingham Central Technical College, Suffolk Street, Birmingham 1 (October 31).

AGRICULTURAL ECONOMIST, an ASSISTANT AGRICULTURAL ECONOMIST, and an ASSISTANT LECTURER IN AGRICULTURAL ECONOMICS—The Registrar, University College of Wales, Aberystwyth (October 31)

SENIOR LECTURER IN STRUCTURAL ENGINEERING, a LECTURER IN MECHANICAL ENGINEERING, and a SENIOR LECTURER IN MECHANICAL ENGINEERING, at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W C.1 (October 31)

LABORATORY STEWARD (Grade B) IN THE DEPARTMENT OF CHEMISTRY —The Medical School Secretary, Middlesex Hospital, London, W 1 (October 31).

SPEECH THERAPIST—The County Medical Officer, County Offices, Lincoln (October 31)

DEMONSTRATOR IN THE PHYSIOLOGY DEPARTMENT—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street London, W C 1 (November 2)

ASSISTANT LECTURER IN GEOLOGY—The Registrar, University College, Singleton Park, Swansea (November 2)

UNIVERSITY LECTURERS and UNIVERSITY DEMONSTRATORS IN ENGINEERING—The Secretary of the Appointments Committee, Engineering Laboratory, Cambridge (November 4)

ASSISTANT TECHNICAL SECRETARY (University Degree or equivalent qualification in Chemistry (inorganic) or Metallurgy essential) by the Metallurgy Division—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed "Metallurgy Division" (November 9)

LECTURER IN BACTERIOLOGY—The Registrar, The University, Manchester 13 (November 9)

PROFESSOR OF GEOLOGY AND HEAD OF THE DEPARTMENT OF GEOLOGY AND GEOGRAPHY—The Registrar University College Singleton Park, Swansea (November 9).

ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Leeds 2 (November 9)

PROBATIONARY ASSISTANT LECTURER IN PHYSICS—The Registrar, University College of North Wales, Bangor (November 9).

LECTURER OR ASSISTANT LECTURER IN THE DEPARTMENT OF ANATOMY, and an ASSISTANT LECTURER IN ELECTRICAL ENGINEERING —The Secretary, King's College, Strand, London, W C 2 (November 9)

SENIOR LECTURER IN PHYSICS in the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W C 2, quoting A 328 (November 12)

SENIOR LECTURER IN ZOOLOGY in the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W C.2, quoting G 412 (November 12)

METEOROLOGICAL OFFICER CADETS (20) in the Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (November 15)

SENIOR LECTURER IN PHYSICS, a LECTURER IN GEOGRAPHY, a LECTURER IN PHILOSOPHY, and a LECTURER IN ECONOMICS, at the Auckland University College, Auckland, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W C 1 (November 15).

TEACHER OF COMMERCE in the County Technical Secondary School for Boys—The Principal, Canterbury Technical Institute, Longport Street, Canterbury (November 16)

SENIOR LECTURER IN ORGANIC CHEMISTRY—The Registrar, The University, Sheffield (November 16)

FOREST ENTOMOLOGIST (Male) at the Forest Research Station, Alice Holt, Farnham, Surrey, under H M Forestry Commission—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1, quoting No 1657 (November 18).

PHYSICIST FOR RESEARCH ON THE PROCESSES OF COMBUSTION, and an ENGINEER FOR VIBRATION INVESTIGATIONS, at the National Gas Turbine Establishment—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1, quoting No 1658 (November 18)

PRINCIPAL SCIENTIFIC OFFICERS (2) for research and development work on Flutter, Aero-elasticity and General Airframe Vibration, at the Royal Aircraft Establishment, South Farnborough—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1, quoting No 1659 (November 18)

SENIOR LECTURER IN BIOLOGY at the New England University College, Armidale, N S W, Australia—The Registrar, The University, Sydney, N S W, Australia (November 30)

DIRECTOR OF THE RUBBER RESEARCH INSTITUTE OF MALAYA—The Acting Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, South Kensington, London, S W 7 (December 10)

CHAIR OF VETERINARY SCIENCE, and the HUGHES CHAIR OF VETERINARY PATHOLOGY AND BACTERIOLOGY—The Registrar, The University, Sydney, N S W, Australia (December 31)

HEAD OF THE ENGINEERING AND SCIENCE DEPARTMENT—The Principal, County Technical College, Worksop, Notts

AREA SUPERVISOR to supervise the work of the National Milk Testing and Advisory Scheme in North Staffordshire and to take charge of the Newcastle Area Laboratory—The Advisory Bacteriologist, Provincial Laboratory, Bank House, Newport, Shropshire

SENIOR MUSEUM ASSISTANT—The Secretary, Department of Zoology, University Museum, Oxford

LABORATORY STEWARD and LECTURE ASSISTANT IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College, Hull

LABORATORY TECHNICIAN with training in pathological and bacteriological technique for the City Hospital Laboratory—Dr. J Smith, Public Health Laboratories City Hospital, Aberdeen

ASSISTANT BIOCHEMIST—The House Governor, Queen Elizabeth Hospital, Birmingham

TECHNICAL ASSISTANT (graduate, preferably in physics or electrical engineering) to help with abstracting, answering technical inquiries, and classifying technical literature—The Secretary, British Scientific Instrument Research Association, 26 Russell Square, London, W C 1

TECHNICAL ASSISTANT FOR PHYSICS DEPARTMENT—The Professor of Physics, The University, Manchester 13, quoting FAV

LIBRARIAN for special technical library—The Information Manager, Production Engineering Research Association, Frederick Street, Loughborough, Leics

LABORATORY STEWARD FOR THE CHEMISTRY DEPARTMENT—The Secretary, Wye College, Wye, Ashford, Kent.

LECTURER OR ASSISTANT LECTURER IN MATHEMATICS—The Registrar, Westfield College, Hampstead, London, N W.3

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Scientific Institutions, Societies and Research Workers in the Netherlands Indies Compiled by Frans and J. G Verdoorn (Reprinted from 'Science and Scientists in the Netherlands Indies'.) Pp 425–460 (interleaved). (New York Board for the Netherlands Indies, Waltham, Mass. Chronica Botanica Co, 1945) Free [154

U S Department of Agriculture Farmers' Bulletin No 1971 The Pea Weevil and Methods for its Control Pp ii + 24. (Washington, D.C Government Printing Office, 1946) [154

Scientific Publications of the Cleveland Museum of Natural History Vol 8, No. 8 A New Arthrodiran Fish from the Upper Devonian Ohio Shales. By David H Dunkle and Peter A Bungart Pp. 85–96 Vol. 8, No 9: Preliminary Notice of a Remarkable Arthrodiran Gnathal Plate By David H Dunkle and Peter A Bungart. Pp 97–102. (Cleveland, Ohio: Cleveland Museum of Natural History, 1945.) [154

Council of Scientific and Industrial Research The Proposed Plan of the National Chemical Laboratory in India Pp iii + 33 (New Delhi Council of Scientific and Industrial Research, 1945.) [164

NATURE

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Editorial and Publishing Offices

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FREEDOM IN SCIENCE

ON p. 574 of this issue we publish an article by Dr. John R. Baker and Prof. A. G. Tansley on "The Course of the Controversy on Freedom in Science", based mainly on the history and development of the Society for Freedom in Science, on p. 590 appears Prof. J. D. Bernal's communication criticizing the two editorial articles on "Conditions of Survival" recently published in *Nature*. Though the article and the letter were submitted to the Editors independently, they raise similar issues, though from different points of view, so it was considered desirable that both should be published simultaneously, not with the view of raising an argument, but rather in the hope of clearing up certain misunderstandings.

Baker and Tansley in their article clearly support the conception of freedom in scientific research and exposition, citing science in Soviet Russia as an example of science in chains. Bernal, on the other hand, implies that Communism supports freedom of investigation. It is quite obvious that taken on their face value both contentions cannot be correct, but no useful purpose is being served, we think, by entering the lists of argument before all doubts and misunderstandings are cleared away. It was in this spirit that the Society for Freedom in Science was offered space in *Nature* to state its aims and objectives. While not necessarily agreeing entirely with all the points of view put forward on behalf of the Society, it seems desirable that its aims should be set forth before the world of science, for there is undoubtedly sound *raison d'être* for the Society at the present time, and its main objectives are worth striving for. We would suggest, however, that the Society be wary of attacking a selected target before making quite sure that it deserves attack. For example, though it is clear that the attitude of the powers in Soviet Russia towards science does not conform to the views held and expressed by the Society for Freedom in Science, it is not so certain that the U.S.S.R. initiated "a movement against pure science and against freedom in science". It would be absurd to claim that there is in the U.S.S.R. that freedom in scientific research and in the expression of opinion of things scientific which is still enjoyed in countries such as Britain and the United States; science in the U.S.S.R. is subject to the State and its policy. It seems to us to be unfair to state categorically, therefore, that the Soviet authorities are deliberately planning an attack on pure science and freedom in science. Things are not so tangible as that, and we have much to learn of each other's points of view. Until then, there should be toleration and real attempts to find out the facts and avoid jumping to conclusions.

For example, *Nature* has repeatedly pleaded for conscious planning of scientific research. This does not mean that the individual research worker must essentially be absorbed into a planned team. Neither does it necessarily involve surrendering one's freedom of choice in scientific research. By planning according to what problems reveal themselves and the capabilities and attitude of the personnel available, we

Library

believe that the best ground and background can be provided for the man of science—individually or in a team—so that he can give of his best. The policy of *laisser-faire* must disappear as the man of science and the layman become more and more aware of science and the impact of science on society. This, we feel sure, is where the pioneers of the Society for Freedom in Science have betrayed the misunderstanding of the points of view of certain other scientific institutions, including *Nature*; for though we claim that the impact of science on society is now achieving such importance as to command constant study which is bound to result in conscious planning, we are equally as convinced that it is the man of science who must be allowed to do the planning in consultation with others. In this way his freedom need not be impaired. We suspect the Society is opposed to political influences being brought to bear in the scientific field—an opposition which receives our support. Provided we are sure of this, then we believe that the five propositions set out as indicating the principles of the Society are of cardinal importance and worthy of full support.

The Society for Freedom in Science is certainly right in insisting that human welfare does not mean only material welfare, and above all the claim that the understanding of Nature is in itself good, apart altogether from the use of that understanding in practical affairs. The Society will do good work by pressing this point of view, for the pursuit of science for its own sake is as important a cultural discipline as the arts and the humanities, and it is therefore of inestimable value in education. Also by pursuing this policy the Society can do much to prevent scientific research becoming degraded to nothing but a search for material developments; for if that happens, fundamental science might well receive a mortal blow and freedom in scientific research disappear entirely from our culture.

The main objectives of the Society for Freedom in Science will best be achieved by constructive proposition. We would not deny the right to criticize opposing views provided it has been made certain that such opposition is real and not merely apparent. Furthermore, as in the case of Bernal's interpretation of the two editorial articles in *Nature*, it is desirable to recognize that there may be other points of view which are not necessarily wrong or, worse still, mischievous. We feel, for example, that Baker and Tansley's charges against the Association of Scientific Workers, the British Association for the Advancement of Science, and the scientific Press for supporting and even taking part in the "new propaganda" are too dogmatic. Their charges imply deliberate action. We do not think such charges are supported either by present-day facts or past history. That there is a threat to freedom in science we would not deny; but we do not consider it is a mutation which appeared in the form of propaganda suddenly in 1931. Civilization is now going through very severe changes, many of them initiated by science itself, and with these changes science, and all that it implies, must move. Never before, therefore, has there been such a need for the Society, provided it chooses its objectives in the light of up-to-date observations and experiences. Failing this, the Society will succeed only in setting up factions, each of which would in no circumstances see good in the other. But with such principles as the Society is propounding, we think it will successfully go along the right lines. Already two of its officers discern what they claim to be a change of front in those whom they originally suspected of being propagandists against pure science and against freedom in science. It may be that they are right and that such a change of front has occurred; perhaps it is being realized that totalitarianism in science does not work On the other hand, it is quite conceivable that at any rate the British Association and the Society for Freedom in Science do not differ so much in ideals as in methods of approach It is clear that the British Association, which stands for the advancement of science, would benefit by collaboration with the Society for Freedom in Science, since in a democratic country it cannot be accepted that advancement is possible in the absence of freedom.

Prof. Bernal's communication reveals keen support for the Soviet political views and attitudes towards science; we are not prepared to discuss these points of view. Readers of *Nature* must be left free to come to their own conclusions. We do not consider it necessary to change or modify the views as set out in the two editorials to which he refers. We feel, however, that supporters of Soviet political and scientific policy should realize that to accuse anyone who attempts to criticize that policy of being a victim of the late Dr. Goebbel's propaganda is now surely outmoded. We do not consider any political doctrine above criticism, and therefore in so far as political doctrines when put into practice frequently affect science, education and research, we must reserve the right to raise our voices. This applies not only to communism but also to democracy. It is quite clear, for example, that the Society for Freedom in Science and *Nature* have not seen eye to eye in the past, but it is equally as clear that since the aims and objectives of both are so similar, in due course misunderstandings can be cleared up.

We agree with Bernal, on the other hand, that " 'respect for human personality, freedom of worship, freedom of investigation' are far from being an exclusive mark of Christian ethics". So also have we on several occasions expressed similar views to his own that "the cultures of Islam, India and China have contributed their share to the common heritage"; but we are sure that most men of science would support us in the view that science must beware of the incursion of national and party politics into its field. For example, is it really true that "the Soviet Union has assisted and upheld . . . freedom of investigation"; when we think of such as the 'genetics controversy' we feel rather doubtful. When science is utilized to support any political doctrine, then it is not above suspicion of veering from its main (and only true) objective—the search for and exposition of the truth. By jealously guarding its right to freedom in expression of opinion, science makes its strongest and most worthy contribution to that new international unity which Bernal clearly hopes will be eventually attained. Though this does not imply freedom to defy the laws of one's own country, it does imply freedom to criticize any political doctrine when it is having a tangible effect on science itself (in this respect the Society for Freedom in Science will prove most valuable). We have, therefore, on several occasions criticized certain communist attitudes; there is no question of "ill-considered intrusions into political topics", for it is useless to close one's eyes to the fact that political creeds do affect science and scientific workers, and when we think the effect is a bad one then we reserve the right to say so. Is the only way to prove one's respect for Soviet Russia to refrain entirely from criticism and become communist oneself? No true man of science can deny another the right to a conflicting opinion, but he should denounce those who persist, as Mr. Bernard Baruch recently put it, "in errors as to facts". We are glad that the Scientific Committee to the Atomic Energy Commission has declared that control of atomic energy is possible, though we note that Prof. Bernal does not consider the refusal of the U.S.S.R. to surrender a part of her national sovereignty such an important issue as "the refusal of the United States to accept prohibition of the atomic bomb, and its insistence on attaching to the Lilienthal report the political condition of the abolition of the veto". On October 8, when Mr. Baruch was presented with the annual plaque of Freedom House for his work as United States member of the United Nations Atomic Commission, he referred to the Russian view that international inspection of atomic research would violate national sovereignty, saying: "better that than international disaster. America is willing to accept inspection, and for some time America would be the most inspected". This statement is worth pondering. We consider Mr. Baruch is right, and the Russian point of view wrong, and surely in saying so we are not putting a stumbling block on that trail to international unity which all clear-thinking men and women wish to see blazed.

We cannot agree with Prof. Bernal that inherent in Anglo-American culture there is a "holier than thou" attitude: if there were, it would indeed be a dangerous weakness. Neither does it seem necessary to warn scientific workers in Great Britain against accepting such a flattering ascription to themselves of the monopoly of moral values. But this surely does not imply, therefore, that they become divested of any right to think, and say what they think, of other cultures, political creeds, other hypotheses and other points of view. We think it is Bernal who is allowing politics to intrude upon his scientific views, and this is the type of attitude which we feel must be checked. This can be done best by ensuring that freedom in scientific research which the Society for Freedom in Science stands for, bearing in mind at the same time the duties that scientific workers owe to their fellow men. Men of science can do best by not allowing their political views to colour their scientific work and attitudes, and in refusing to allow political forces to dictate or in any way influence their work.

BABBAGE'S DREAM COMES TRUE

A Manual of Operation for the Automatic Sequence Controlled Calculator

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vol. 1.) Pp. xiii+561+17 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1946.) 10 dollars.

THE black mark earned by the government of the day more than a hundred years ago for its failure to see Charles Babbage's difference engine brought to a successful conclusion has still to be wiped out. It is not too much to say that it cost Britain the leading place in the art of mechanical computing. Babbage then conceived and worked on his 'analytical engine', designed to store numbers and operate on them according to a sequence of processes conveyed to the machine by cards similar to those used in the Jacquard loom. This, however, was never completed.

The machine now described, "The Automatic Sequence Controlled Calculator", is a realisation of Babbage's project in principle, although its physical form has the benefit of twentieth century engineering and mass-production methods. Prof. Howard H. Aiken (also Commander, U.S.N.R.) of Harvard University inspired the International Business Machines Corporation (I.B.M.) to collaborate with him in constructing a new machine, largely composed of standard Hollerith counters, but with a superimposed and specially designed tape sequence control for directing the operations of the machine. The foremost I.B.M. engineers were assigned to the task; many of their new inventions are incorporated as basic units. When the machine was completed, Thomas J. Watson, on behalf of the Corporation, presented it to Harvard University—yet another token of the interest I.B.M. has shown in science. Would that this example were followed by their opposite numbers in Great Britain! One notes with astonishment, however, the significant omission of "I.B.M." in the title and in Prof. Aiken's preface, although President Conant's foreword carefully refers always to the "I.B.M. Automatic Sequence Controlled Calculator".

The machine contains seventy-two storage counters, each capable of holding twenty-three digits and a sign. For smaller numbers each counter can be split into two, while for larger numbers they can be teamed up. There are also sixty switch-set 24-figure registers, for holding constants; these likewise can be split. There are several special units, two being for multiplying and dividing; these first form nine multiples of the multiplicand or divisor. In multiplication the multiples directed by the multiplier are chosen and added step by step. In division the dividend or remainder is compared with the multiples in succession; that which is just less than the dividend is subtracted, and the appropriate figure of the quotient recorded. When working to the full 23-figure capacity of the machine, multiplication takes about six seconds, and division twice as long; additions and subtractions are done at the rate of three a second, whatever their length.

Three special units (which share many of the machine components) are for calculating logarithms, antilogarithms (or exponentials) and sines (or cosines). The process of calculating a 21-figure logarithm is a combination of the factor method and of the series $\log(1+x) = M(x - x^2/2 + x^3/3 - x^4/4 \ldots)$. The machine first finds four factors, one each from the groups 2 . . 9, 1·1 . . . 1·9, 1·01 . . . 1·09 and 1·001 . . . 1·009, the logarithms of which are specially stored. In the fifth factor x is less than 10^{-3}, so that six terms of the above series suffice, in the form

$$\left(\left(\left(\left(\left(-\frac{M}{6}x+\frac{M}{5}\right)x-\frac{M}{4}\right)x+\frac{M}{3}\right)x-\frac{M}{2}\right)x+M\right)x$$

To find a number from its logarithm, if a, b, c are the first three digits of the mantissa, and d the remaining digits, we have a power of 10 (depending on the characteristic) multiplied by

$$10^{\cdot 1a} \cdot 10^{\cdot 01b} \cdot 10^{\cdot 001c} \cdot 10^{d}$$

The first three of these factors are obtained from a store in the machine for the 27 values corresponding to a, b or $c = 1 \ldots 9$. The last is computed from

$$1 + D + \frac{D^2}{2!} + \frac{D^3}{3!} + \frac{D^4}{4!} + \ldots \text{ where } D = d/M.$$

This unit is known as the exponential unit.

The sine unit first ascertains in which octant x (which must be in radians) lies. This determines the sign of the function, and instructs the machine whether to use the series for $\sin x$ or $\cos x$ for x less than $\frac{1}{4}\pi$. In the worst possible case, 11 terms suffice to give 23 decimals.

It will be seen that these three units give access to all logarithmic, exponential, circular and hyperbolic functions without tables, although other functions can be entered via tapes or cards. Each logarithm, antilogarithm (or exponential) or sine, if to the full capacity of the machine, takes about a minute, which is comparable with the time required by a good computer to look up and interpolate a linear table with ten decimals only.

The brains of the machine lie in the control tape, which is code-punched in three sections. The first instructs the machine where to find its data; the second gives the destination of the data or answer; the third dictates the process. Very often these tapes, being simply a sequence of processes and independent of the actual figures used, as in the evaluation of integrals by quadrature, can be stored in a tape library, and used over and over again.

A problem that has been solved is that of conveying computed results to many users. Tables produced by the machine can be typed by an electromatic typewriter, with vertical and horizontal spaces as required. Reproduction by photolithography eliminates many fruitful sources of error and much drudgery, transcription, composition and proof-reading. Volume 2 of this series is such a table of Hankel functions of order one third, and other tables are in the press.

Prof. Aiken estimates that the calculator is nearly a hundred times as fast as a well-equipped manual computer; running twenty-four hours a day, as it does, it may do six months' work in a day. Perhaps his examples, chosen for their simplicity, do not do the machine justice, because they could be done almost as quickly, and certainly more economically, with a Brunsviga and a National.

The question naturally arises: Does the calculator open up new fields in numerical and mathematical analysis—especially in such pressing problems as the solution of ordinary and partial differential equations, and the solution of large numbers of simultaneous linear equations? It is disappointing to have to record that the only output of the machine of which we are informed consists of tables of Bessel functions, which are not difficult (to the number of figures required in real life) by existing methods and equipment. If the machine is to justify its existence, it must be used to explore fields in which the numerical labour has so far been prohibitive.

A useful 65-page bibliography of numerical analysis will be welcomed by all interested in computation.

L. J. COMRIE

SOCIAL PÆDIATRICS

Child and Adolescent Life in Health and Disease

A Study in Social Pædiatrics. By Dr. W. S. Craig. Pp. xvi+667. (Edinburgh: E. and S. Livingstone, Ltd., 1946.) 25s net

IN writing this book Dr. Craig has broken new ground and made available, for the first time, a history of social pædiatrics. The scope of the work is formidable, and the enthusiasm and industry which he has brought to his task impressive. Everyone concerned with the care of children, whether expert pædiatrician or general practitioner, health visitor or social worker, will be grateful for the wealth of information which has now been placed at their disposal, and it seems reasonable to predict that this work will remain a standard book of reference for many years.

In the first part of the book there is given a lucid and unemotional account of the philanthropic and State-aided services for infants and children in Britain from the earliest times "when vice and lust predominated to such an extent that little compassion prevailed for the child". The needs of the poor in those far-off days were dealt with by the monastic orders. Later, with the dissolution of the monasteries, these responsibilities were taken over by the 'hospitals' and charity schools. In 1601, the Act for the Relief of the Poor was passed by Parliament, and thus we have the first attempt to secure a systematic form of relief. In 1740, workhouses, orphanages and the foundling hospitals came into being. Then followed the industrial era with its terrible conditions of child labour; but all the while, the record shows steady progress being made through voluntary effort and by Act of Parliament. Such institutions as the Ragged School Movement (1780), later to be known as the Shaftesbury Society, Dr. Barnardo's Homes (1870) and the Invalid Children's Aid Association (1888) were established, and these still contribute to the welfare of poor children. The voluntary hospitals and the development of pædiatrics as a branch of general medicine, the child welfare centres and the education authority with its medical services all receive their due share of the credit for the steady improvement brought about.

Dr. Craig then goes on to describe, in detail, the present services for the healthy and handicapped child as they exist to-day, not forgetting to mention the problems of total war. He rightly complains of the overlapping and lack of co-ordination of the existing measures, and in these days when the shadow of a State service looms large there is an urgent need for some plan to prevent wastage. But is this all to be controlled by the State? It would be well to look back over the years and remember the magnificent work done by voluntary effort. In the field of pædiatrics, either medical or social, there is a great need for the 'human touch', and to organise too rigidly on purely clinic and institutional lines would be unfortunate. One problem which, to the reviewer, does not seem to have been given the attention it deserves is that of housing. If one regards the family in the home as the unit—and surely this is right—provision of adequate housing and labour-saving devices for the housewife should rank in the forefront of any scheme to improve the lot of the less fortunate children. The net reproduction-rate is below unity in Great Britain, and the population is being maintained by the greater expectation of life now existing. Whatever aspect of social pædiatrics one discusses, from the birth-rate to juvenile delinquency, adequate housing of the poorer classes is a fundamental problem. Dr. Craig rightly states that "ultimately public opinion will determine the standards of provisions to be made for the care of child life and health". There is evidence now that the public regard adequate housing as one of the essential provisions.

This is a stimulating book, and in every chapter problems are raised which, when the time of planning gives way to the time of action, will require to be solved. "It is only from the past that one can judge the future", and here we have the past arrayed before us for our study, and it is to be hoped that good use of it will be made by the planners.

The book shows no evidence of war-time austerity. It is printed on excellent paper and is profusely illustrated, a credit to the author and to the publishers. STANLEY GRAHAM

SOFT FRUITS

The Cultivation of Berried Fruits in Great Britain

History, Varieties, Culture and Diseases. By Chas. H. Oldham. (Agricultural and Horticultural Handbooks.) Pp. 374+8 plates. (London: Crosby Lockwood and Son, Ltd., 1946.) 21s. net.

JUDGED on the basis of commercial acreage, the cultivation of small fruits in Great Britain is not great in comparison with other classes of crops. In 1939 the total area devoted to berried fruits in England and Wales was 47,000 acres, and the restrictions of war-time reduced this to 33,000 acres in 1944. This is very small compared with the 250,000 acres of so-called 'top' fruits, apples, pears, plums and cherries. Nevertheless, the high economic returns per acre of the soft fruits and their value in the diet make their cultivation an important item in the horticultural production policy of Great Britain. In spite of their relatively short season, strawberries remain the most popular of the small fruits and account for nearly half of the total acreage. Dietetic research during the last ten years has shown that the blackcurrant is by far the richest source of vitamin C of all cultivated crops, and it is probable that we may look to a considerable increase in its production in the future.

Financial returns with soft fruits, however, vary enormously with differences in cultivation, choice of varieties and, above all, incidence of pests and diseases. Strawberries, to take the extreme example, may give crops of as much as five or even six tons per acre, but the average yield over a series of years for the whole of Britain is less than a ton, due largely to the prevalence of virus diseases in commercial stock.

It is clear, therefore, that an authoritative book on the cultivation of these kinds of fruits is of the greatest value to the grower in advising him of the best methods of production and the pitfalls to avoid. Mr. Oldham, in his position as a horticultural inspector of the Ministry of Agriculture, speaks with this requisite authority from his years of experience among growers, and he has prepared a volume containing a great deal of invaluable information on the history and commercial production of our principal small fruits.

It is clear that the book was mainly written before the War; the statistical and economic data refer only to 1939 and earlier, and are therefore in many cases of little present value even without the occasional errors as, for example, on p. 206 where the acreage of gooseberries in the Tamar Valley and the Exeter area is stated to be about four hundred acres, though on p. 202 the total area of this crop in Devon is given as 185 acres.

Here and there also are other more serious errors which it is hoped will be corrected in a future edition. For example, in the account of the breeding work on the cultivated species of *Rubus* at the John Innes Horticultural Institution, there is confusion over the origin of the varieties 'John Innes' and 'Merton Thornless'. The former, a tetraploid variety, was raised by crossing the thornless diploid, *R. rusticanus inermis*, with the thorny, tetraploid, *R. thyrsiger* (incorrectly spelt throughout as "*R. thyriger*"), an unreduced egg-cell of the former combining with the normal haploid sperm-cell of the latter. The new variety was as thorny as the male parent, but some seedlings in the F_2 generation were thornless, and one of these was the valuable tetraploid, "Merton Thornless", to which no reference is made in the book.

It is also to be hoped that a second edition will receive more careful editing. Sub-headings, always difficult in a book of this type, are very confused, most particularly in Chapter 38; the numbering of tables seems without rhyme or reason, some receiving a number, others, of precisely the same type, remaining unnumbered. Incidentally, the strange practice is followed of printing the number in words.

In the section on raspberries, Chapters 24 and 26 are confused in their substance and need to be combined into a single chapter.

In the classifications of varieties in each kind of fruit the value would be greatly enhanced by giving one classification only and confining it to the varieties in cultivation at the present time. In gooseberries, for example, two lengthy classifications are given, one quoted verbatim from Hogg and containing long lists of varieties now entirely lost.

The treatment of pests and diseases is usually adequate, though Latin names are often misspelt; but in the section on strawberries, in general the most valuable and authoritative part of the book, more attention might be given to the all-important virus diseases and especially to the great work of East Malling Research Station in raising and distributing virus-free clonal stocks. Following on this, the omission of reference to the present-day system of official certification of stocks is a serious gap.

The black-and-white illustrations, to the author of whom no acknowledgment is made, are delightful, and it is a pity that half-way through they give place to photographs, some of which are of little value.

Two other matters calling for attention in a second edition are the symptoms of mineral deficiencies and the causes and avoidance of frost damage.

R. H. STOUGHTON

"999—Emergency!"

By Arthur W. Spencer-Bragg. (Social Science Series, No. 4.) Pp. 64. (London: Social Science Association, 1946.) 2*s*. 6*d*.

THIS fourth pamphlet in the Social Science Series is a great advance in style, printing and content over the third pamphlet ("Post-mortem on Fascism", by Morris Richards), and in spite of a tendency to quote excessively from journalism, and himself to display some of its poorer characteristics, Mr. Spencer-Bragg has produced a more readable pamphlet than his title might suggest. He presents fairly enough some of the dangers of an uneducated or partly educated democracy in the world to-day, and his examination of the different conceptions of democracy which divide the world to-day and of the question whether a single world system in which economic democracy and political democracy co-exist is possible is reasonable. He sees such a system as the only condition upon which civilization can survive, and he appears to rest his hopes on a comparatively small number of scientifically minded persons being able to obtain mass support and approval, if not full understanding, of their outlook and policy. But while Mr. Spencer-Bragg emphasizes the need for scientific understanding of human society and for the scientific study of such problems, he shows himself strangely insensitive to values, and above all to the need for a moral and spiritual basis for world order. The materialistic outlook is rather too prominent for the author's diagnosis to be entirely convincing, and one's distrust is increased by his partiality for ideology which, somewhat prematurely as it seems to one reader, he exalts to the level of a science.

R. B.

Rationalism in Education and Life

Papers read at the First Annual Conference of the Rationalist Press Association, held at Wadham College, Oxford, August 1945. Pp. v+149. (London: Watts and Co., Ltd., 1946.) 5*s*. net.

THE book under notice contains a full report of the papers read at the first annual conference of the Rationalist Press Association, held at Wadham College, Oxford, during August 1945, under the presidency of Sir John Hammerton. Besides dealing with more general problems, the programme was designed to elicit discussion of the rationalist policy for religious education in schools. It is to be noted that during the war years this subject was not neglected in the columns of *Nature*: witness, for example, a review of January 23, 1943, of Mr. A. G. Whyte's pamphlet maintaining that the omission from religious instruction of all non-Christian faiths would be hard to justify in those times. Again, in an editorial in *Nature* of November 14, 1942, it was pointed out that on the question of religious education men of science differ as much as other intelligent people, for, as Pascal said long ago, "the heart has its reasons, of which reason itself knows nothing".

The present volume gives a comprehensive survey of the problem of rationalism in education, of the theoretical basis of rationalism, and of rationalist philosophy. A movement associated with such names as those of Gilbert Murray, John Dewey, R. A. Gregory, Albert Einstein, Julian Huxley, to mention only a few, has a valuable part to play in purging contemporary thought and practice of the taint of superstition.

Four Dialogues of Plato, including the 'Apology of Socrates'

Translations and Notes by John Stuart Mill. Edited, with an Introductory Essay, by Ruth Borchardt. Pp. vi+194. (London: Watts and Co., Ltd., 1946.) 10*s*. 6*d*. net.

DR. RUTH BORCHARDT has performed a valuable service in rescuing from oblivion—as she puts it—these translations by John Stuart Mill of four Platonic dialogues, namely, the "Protagoras", the "Phraedrus", "The Georgias", and the "Apology of Socrates". They appeared originally in the *Monthly Repository* of 1834–35, and have been almost neglected ever since. In addition, we are given a reprint of the essay "On Genius", written over the signature "Antiquus", in which 'J. S. M.' probed the depths of knowledge, as he saw it, with unrivalled skill of phrase.

The present brief notice firmly resists the temptation (and presumption) to review Mill: enough, therefore, to say of this essay that perhaps its chief claim to distinction lies in the high place accorded to conceptive genius. Dr. Borchardt herself contributes a pleasing introduction entitled "John Stuart Mill and the Ancients". From it, students may catch a glimpse of that great nineteenth century mind, weighed down by contemporary problems, nevertheless sustained and fortified by the remote past; continuity and tradition each playing its part in a true education.

All very excellent; yet why must the editor disfigure her book by a choice of word in the dedication so utterly inappropriate and graceless?

F. IAN G. RAWLINS

Preliminary Check List of the Flowering Plants and Ferns of Griqualand West (Southern Africa)

By M. Wilman. Pp. vii+382. (Cambridge: Deighton Bell and Co., Ltd.; Kimberley: Alexander McGregor Memorial Museum, 1946.) 45*s*. net.

IT appears from the preface that "this volume is a substitute, but only a temporary one we hope, for the more ambitious work . . . in course of preparation at the outbreak of war". The author was apparently impressed by the need for a text-book dealing with the plants of Griqualand West, and this preliminary check list appears to be the outcome of this impression.

The volume contains, in addition to the list of plants with localities, a glossary of the terms used, a list of the common names with their botanical equivalents and a "Farm Map of Griqualand West", which covers all the localities where collections were made.

It is to be hoped that in the more ambitious work contemplated opportunity will be taken to correct certain nomenclatural errors which stand in need of amendment. While consulting the list it is difficult to resist the impression that insufficient care was taken in checking the manuscript, probably due to war-time difficulties. Produced as a result of field work extending over thirty years, often handicapped by bad local conditions, the author, in spite of these slips, is to be congratulated in the production of an interesting and useful volume, which will form a valuable basis for future work.

It is probable that the sale of a work of this type, which should be available to all field botanists, will be restricted on account of its high price.

PHYSICS AND CHEMISTRY OF SWELLING AND SHRINKING

THE general discussions of the Faraday Society are usually notable for the breadth of their scope, and the latest, held during September 24–26 at the Royal Institution, London, was outstanding in this respect. More than thirty papers were presented under the general title of "Swelling and Shrinking", dealing with topics ranging from the thermodynamics of liquid mixtures to the behaviour of complex biological and technical systems. These were grouped in three sections: fundamental, biological, and technical. Prof. J. D. Bernal gave a general introductory talk, and the second and third sections were introduced respectively by Prof. E. K. Rideal and by Dr. L. G. Gabriel.

In attempting to summarize briefly some of the salient features of the discussion, attention may first be directed to two diametrically opposed methods of attack. The first is concerned with the simplest possible types of system, comprising essentially non-polar polymers and liquids, and as free as possible from structural features. At the other extreme lie certain aqueous systems which have been found by X-ray examination to possess very definite structural regularities.

Various methods of investigation have been applied to non-polar systems, and a great deal of progress has been made in recent years in the interpretation of the thermodynamic properties of polymer liquid mixtures. Lattice models have been made the basis of statistical calculations of the heat and entropy of solution of polymers. Discussion of recent progress in this field revealed the lack of an adequate treatment of dilute solutions, taking accurate account of the extent to which a single polymer molecule is folded or crumpled by its random thermal motion. Measurements of the intensity of light scattered by a polymer solution, and its distribution about the direction of incidence, are now being used to give direct estimates of the root mean square length of a polymer. Preliminary results reported at the discussion give values some four times larger than those computed for an ideally flexible and volumeless chain, and these lengths do not appear to be very dependent on the nature of the liquid. Mixtures of higher polymer content have been treated with greater success, but evidence was presented that liquids which are only sparingly absorbed are present in the nearly saturated polymer in the form of small clusters. This behaviour, which probably has a counterpart in liquid mixtures, has not been satisfactorily explained.

Less progress has been made in the quantitative interpretation of viscous flow and diffusion in these systems, although the qualitative features observed are readily understood. An outstanding problem in calculating the viscosity of a dilute solution is to decide whether liquid is effectively trapped by the crumpled polymer chain, or flows freely through it. Both assumptions have been made, and the experimental evidence suggests an intermediate state of affairs, possibly somewhat dependent on the solvent. New evidence presented at the discussion was concerned with model suspensions of flexible particles cut from cellulose fibres and swollen. These were, of course, of much more than molecular dimensions, and liquid was observed to flow freely through their folds. Nevertheless, the viscosity was found to depend on the overall length, rather than the mean length taken up by the particles when suspended in liquid.

Several examples were discussed of systems which possess regular structures when highly swollen by water or aqueous media. One of the most remarkable of these is furnished by dilute solutions of tobacco mosaic virus. X-ray examination shows the rod-like molecules to be arranged in a regular hexagonal pattern, with a spacing which may be as much as 500 A., depending on the medium, but not on the length of the rods. Regular structures with even larger separations are observed in sols of ferric and tungstic oxides, the plate-like particles of which form 'Schiller layers' with separation as great as 8000 A. Two types of explanation of these structures assume on one hand a supporting framework, and on the other, the existence of long-range forces. It is difficult to see how the very regular framework needed could arise, and it was generally assumed by contributors to this discussion that long-range forces must be responsible. The origin and nature of these forces is by no means clear, and much difference of opinion was expressed The two main suggestions were that the necessary free-energy minimum arises from a balance between attractive and repulsive forces, both electrostatic in origin, or between van der Waals' attraction and electrostatic repulsion. On either view it appears difficult to account for the existence of a free-energy minimum sufficiently deep to confer reasonable stability on the structure.

Another very striking example of an aqueous system possessing structure is furnished by protein crystals. X-ray examination of horse methæmoglobin shows the swollen crystals to consist of alternate layers of hæmoglobin molecules and liquid. Swelling and shrinking produce discontinuous changes in the layer spacing and in the β angle of the crystal. In this case the spacing does not exceed 15 A., so that a definite structure may well extend through the complete liquid layer.

Hydrated clays, such as montmorillonite, show similar laminated structures, in which swelling and shrinking occur by variations in the thickness of the water layers. Experiments on the swelling of dehydrated montmorillonite in polar organic liquids were also reported; as many as three molecular layers of nitromethane or acetonitrile could be intercalated between successive clay layers, the spacing then being of the order of 20 A. Evidence was presented that these layers were essentially liquid.

A number of systems showing structure on a microscopic scale were described by various contributors to the discussion. When lecithin swells in water, the particle is observed to develop cylindrical excrescences which retain a constant diameter, and do not coalesce on contact. These have been termed 'myelin forms', and similar arrangements have been found with other systems, including the complex formed by association of cholesterol (insoluble) with lysolecithin (soluble). By using complexes of increasing solubility, it has been found possible to produce in succession a series of structural types which had been previously reported. These include (1) 'batonnets', consisting of axially symmetrical particles with characteristic bulges which coalesce on contact, giving new particles of the same type; (2) long spindle-shaped 'tactoids'; (3) 'coacervates' containing spherical particles. It was suggested that the basic molecular organisation in these structures is again laminar, with the fluid content of the swollen phase intercalated between crystalline layers.

An interesting series of transparent 50 per cent oil-water systems was described. If amyl alcohol is added to an emulsion stabilized by sodium oleate, the system becomes transparent, and is believed to contain suspended droplets of the order of 100–200 A. in diameter. Amyl alcohol can be replaced by other amphipathic compounds, their efficiency depending on the ratio polar/non-polar. This was investigated in the series of aliphatic alcohols, from C_1 to C_{10}, and it was found that with benzene as the 'oil', the continuous phase changed from water to oil when the chain-length exceeded 5. These results are explicable in terms of the formation of mixed films of soap and alcohol at the interface; such films are known to be stable from experiments in monolayers.

Between these two extremes of structureless and highly ordered systems lie many of considerable importance, which may be treated as approximating more or less closely to one extreme or the other. Two papers discussed the structure and deformation of cellulose gels in the light of the work on ideally elastic rubber-like bodies. Theoretical treatments of the latter have been based on a model consisting of long randomly linked chains joined at a few points into a complete three-dimensional network. A statistical mechanical analysis of this model leads to expressions for the free energy of deformation, and the orientation birefringence. Swollen cellulose shows a limited degree of rubber-like elasticity, but in order to account for this quantitatively it has been necessary to assume a very high degree of cross-linking. It may be considered doubtful whether much significance is attached to the model when the estimated number of statistical chain elements between junction points falls so low as one or two.

The swelling of nitrocellulose is more complicated than that of a purely amorphous polymer, on account of its definite structure. Two types of swelling were reported, depending on whether the crystalline part is affected or not.

The swelling of protein fibres in organic solvents was discussed from the point of view of the fibre structure. The relative effectiveness of a range of acids, amides and alcohols suggests that swelling involves the breakdown of the fibre structure by chemical interactions between the liquid and localized groups in the fibre. No simple generalization of these results, such as may be made for the swelling of non-polar polymers, was found to be valid in this case.

The phenomena of swelling and shrinking are of great importance in many widely divergent fields. In the technical use of materials capable of absorbing water, or other liquids, the resultant change of volume may be less serious than the stresses and strains which are produced. A thermodynamic analysis of the swelling of wood was presented, in which the cell structure was represented by a hollow cylinder of initially isotropic material surrounded by a rigid sheath, so that swelling could only occur into the central lumen. It is then possible to deduce the dependence of the vapour pressure at fixed moisture content on the elastic constants of the swollen cell wall. The swelling of laminated plastics represents a closely related problem. Imbibition of moisture by the reinforcing fibre is mechanically restrained by the surrounding film of polymer, which in general will itself be swollen to a smaller degree.

A very different field of application of the general ideas developed in this conference is presented by systems of biological interest. On the simplest view, a red cell may be treated as a balloon-like body surrounded by a semi-permeable membrane of very low modulus of elasticity. The volume of the cell, which can now be measured with some accuracy, should thus be dependent on an osmotic equilibrium, and would vary with the medium in which the cell is immersed. Experimentally, there are found to be discrepancies which are not at present fully understood. Complications were pointed out also in the swelling of protoplasm. It is not yet clear how far the various physical processes occurring in living matter may be treated as though they are *identical* with those of the dead chemical constituents of the systems. Without in the least suggesting any vitalistic hypothesis, it is necessary to bear in mind the essentially dynamic nature of living cells, and the simultaneous occurrence of complex chemical and physical changes.

GEOFFREY GEE

THE MOON AND PLANT GROWTH

By DR. C. F. C. BEESON, C.I.E.
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BELIEFS that the phases of the moon have a differential effect on the rate of development of plants are both ancient and world-wide. Proof by rational experiment seems to have been sought more than two hundred and fifty years ago by La Quintinye, the horticulturist, and some years later by Duhamel du Monceau[1], the forester. Neither obtained any positive evidence of lunar influence. Since then, scientific interest in the subject has been revived intermittently, either by the 'rediscovery' of lunar rites in the agriculture of civilized countries, or by the impact on Europeans of the impressive faith of primitive peoples, particularly in the tropics and sub-tropics.

The literature on the moon and plants can be assigned to two groups: one comprising reiterations of peasant beliefs, myths and rules, both ancient and modern, and similar unsubstantiated statements, the other comprising experiments supported by numerical data capable of statistical analysis. This second group consists of (*a*) experiments mainly of the anthroposophical school, which demonstrate the existence of lunar effects on the growth of plants; and (*b*) experiments of professional horticulturists and foresters, which prove that there are no such effects, or that, if they do exist, they have no value in agricultural practice.

The beliefs which dominate primitive rural economy and the emphatic reports of credulous observers are very numerous, but they provide no significant evidence. Only experimental data need be considered; they may be briefly summarized as follows:

(*a*) *Kolisko's work.* According to the investigations of L. Kolisko[2] in Stuttgart during 1926–35, the particular phase of the moon at the time of sowing does influence the period and the percentage of germination, as also the subsequent growth of the plant. The most favourable date to sow is two days before the full moon for leaf- and fruit-bearing garden crops (such as cabbages, peas, tomatoes), for root-crops (such as radishes, beetroots, carrots), for flowering garden annuals, and for wheat, maize, etc. In general, these plants show better germination, more vigorous growth, and greater yields than those sown just before the new moon. Kolisko affirms that the lunar influence is not fully effective unless there is rain or artificial watering during the germination period, but the stimulus once acquired remains decisive throughout the periods of growth, flowering and fruiting As regards growth during a lunar phase, she found that on the whole the response of wheat is greater during the waxing than the waning phase.

In later experiments to determine the depth to which the action of the moon penetrates the soil, Kolisko found that at a depth of 1 metre the effect on wheat is nearly identical with that at the surface; at 2–3 metres the maximum growth is generally reached in a full-moon period; between 5 metres and 16 metres the influence is weaker but is still shown by greater growth at the time of the Easter full moon. She considers that each year has a certain dominating lunar period, and that the Easter full moon has a special significance for the whole year. E. and L. Kolisko's recent book, "Agriculture of Tomorrow", reviews cosmic influences on plant growth.

(*b*) *Other investigators' work*. *Germination*. Experiments on the germination of garden crops have been done by Becker (1937–38)[3], Bergdolt and Spanner (1937–39)[4] at Munich; by Mather and Newall (1940–42)[5,6] at the John Innes Horticultural Institution; similar experiments with spruce seed were done by Rohmeder (1935–37)[7] at Munich. All these investigators agree that no consistent effect of the moon is observable, and that all chance variations possibly assignable to any one of the moon's quarters are evened out with an adequate number of repetitions. At meetings of the Société nationale d'horticulture de France in 1924, several horticulturists testified to the absence of lunar effects on sowings and seedling growth; earlier work of Arago, Flammarion and others in France between 1859 and 1909 was cited in confirmation[8].

Reproduction. Periodicity in the production of sexual cells of the marine alga, *Dictyota dichotoma*, has been demonstrated by Williams (1905)[9], Hoyt (1907)[10] and Lewis (1910)[11], but the period is fortnightly on the coast of Wales and Naples, and four-weekly in New Carolina, and the phase dates differ.

Polarized light. Semmens (1923)[12] showed that moonlight is plane-polarized and increases hydrolysis of starch with diastase. Esenbeck and Suessinguth (1930)[13] and Macht (1926)[14] showed that polarized light of low intensity may produce a very slight increase in growth in length of plants. Wright (1927)[15] found the highest degree of polarization of moonlight at the ends of the first and third quarters. The anthroposophists consider that the moon's influence works in darkness and below ground.

Felling dates and seasoning of timber. Moisture-content is the most important physical condition influencing the rate of decay of wood. The amount of water in the wood of a living tree is known from many careful determinations to differ with the species of tree, and for some species to vary seasonally, for others to be fairly constant throughout the year. No variation related to lunar phases is known for any tree, but Beeson and Bhatia (1936)[16] found a regular lunar rhythm of sap increasing from the full to the new moon and decreasing from the new to the full moon in *Dendrocalamus strictus* in India. Knuchel and Gaumann's (1930)[17] work with spruce and silver fir in Switzerland based on a sequence of fellings in the same phase of the moon is typical of the exact knowledge now available. The season of felling is proved to have no substantial influence on specific gravity, moisture-content, shrinkage, resin-content or working qualities, but it strongly influences the rate of seasoning. The effect of the season of felling on the rate of drying, and the effect of weather on the activity of decay organisms dominates any effect that may be due to the phase of the moon.

Borer damage. Numerous entomological records show that the liability of felled trees to attack (that is, oviposition) by borers depends on one hand on the dates of the emergence period and longevity of the adult insect, and on the other hand on the progress of drying out of bark and sapwood, or the amount of depletion of starch. The two latter factors can be controlled in many species of trees by logging procedure which entirely ignores lunar dates. Beeson and Bhatia (1936)[16] and Gardner (1945)[18] have proved that the intensity of *Dinoderus* damage to bamboos in India depends on the amount of starch present in the felled culm; the starch-content of the living culm varies seasonally, not according to the lunar phase, and no advantage is obtained by felling in relation to the phase date.

Lunar periodicity exists in some animals, but they are marine or aquatic species (Fox, 1924[19]; Hora, 1929[20]).

Yield of resin, latex, etc. Variations in the yield of resin, latex, maple syrup, gums and tannin are explicable in terms of tapping systems, genetic factors, weather and environmental conditions; experience is very considerable, but in no case has any advantage attributable to the moon been discovered. For example, Ferrand's work (1941)[21] on *Hevea brasiliensis* in the Belgian Congo revealed that the daily concentration of latex varies with weather conditions, and the local concentration in the same tree depends on the exposure to sunlight of the crown directly above the tapping-point. Changes in the gutta-content of the root of *Euonymus verrucosus* in the U.S.S.R. follow the seasonal development of the plant, and the resin-content varies in inverse proportion (Yurkevich, 1944)[22]. The maximum tannin-content of seeds of *Terminalia chebula* is found in seeds collected in January anywhere in India; this period is also that of optimal germinative capacity (Prasad, 1946)[23].

Summary. The only experimental evidence for the existence of lunar influence on the growth of land plants is that published by L. Kolisko. All other investigators in many parts of the world have been unable to discover any consistent correlation between the moon and the vital processes of land plants; some admit that if a lunar effect does exist it is so obscure as to have no value in agricultural practice.

A more detailed review of the subject will shortly be published by the Imperial Forestry Bureau, Oxford.

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THE COURSE OF THE CONTROVERSY ON FREEDOM IN SCIENCE

By Dr. JOHN R. BAKER
AND
Prof. A. G. TANSLEY, F.R.S.

THE movement against pure science and against freedom in science was first brought to Great Britain by the Soviet delegation to the International Congress on the History of Science held in London in 1931. Before that time it was accepted as a matter of course that the pursuit of pure science by independent research was a worthy and admirable thing, that it was desirable for qualified people to devote their lives to the increase of knowledge as an end in itself, and that research workers at universities should have full liberty to choose the subjects of their own investigations. One may search the literature in vain for any contrary view, and no such view can have been held by more than a minute fraction of the scientific world.

It was, of course, well known to everyone that many branches of pure science could be, and were, applied to practical uses, and that in fact the material equipment of modern societies had been and was being built up through such applications. But the distinction between pure and applied science, between the pursuit of knowledge for its own sake and the application of such knowledge to practical ends was never called in question.

Owing to the world-wide economic depression, attention in 1931 was naturally focused on economic matters, and this preoccupation lent impetus to the specifically Marxist doctrine, then brought to England from Russia, that all scientific progress was really determined by economic causes and that all scientific work should be consciously and directly devoted, under central control, to the material service of the State. This movement spread slowly at first, and then at an ever-increasing speed, as one powerful organisation after another took up the new theme. First and foremost the Association of Scientific Workers, then the British Association and the scientific Press, all began to support and even take part in the new propaganda. It was spread by many who had no sympathy with Marxism and were often unfamiliar with the philosophical basis and implications of the doctrines they were propagating. Scarcely anyone came forward to uphold the contrary doctrine of freedom of research, on which the progress of the general body of science had for centuries been based.

It was not until 1939 that any real opposition to such materialist propaganda arose. In the following year the Society for Freedom in Science was founded. Its principles are contained in the following five propositions, to which each member gives assent on joining:

(1) The increase of knowledge by scientific research of all kinds and the maintenance and spread of scientific culture have an independent and primary human value.

(2) Science can only flourish and therefore can only confer the maximum cultural and practical benefits on society when research is conducted in an atmosphere of freedom.

(3) Scientific life should be autonomous and not subject to outside control in the appointment of personnel or in the allocation of the funds assigned by society to science.

(4) The conditions of appointment of research workers at universities should give them freedom to choose their own problems within their subjects and to work separately or in collaboration as they may prefer. Controlled team-work, essential for some problems, is out of place in others. Some people work best singly, others in teams, and provision should be made for both types.

(5) Men of science in countries not under dictatorial rule should co-operate to maintain the freedom necessary for effective work and to help fellow scientific workers in all parts of the world to maintain or secure this freedom.

The Society has never denied that organised and directed team-work is necessary for the exploration of many of the complex problems of modern science, as well, of course, as in the applications of science to industry; but a considerable degree of freedom for initiative is desirable in both fields.

A cardinal point in the Society's policy has been to insist that human welfare does not mean only material welfare. Everyone agrees that the results of scientific research should be applied to improve the food of the community, to maintain its health, to raise its standard of living, to provide increased conveniences and facilities of all kinds and adequate leisure for all. But, important as they are, these things, after all, are only means to ends, not ends in themselves. The Society sustains the belief that an understanding of Nature is in itself good, apart altogether from the use of that understanding in practical affairs. This belief has been the mainspring of scientific advance for centuries, and is still its mainspring. The attempt to destroy it is not progress. The true progressive recognizes that genuine and potentially permanent progress has been made in human history, and that further progress must be built upon it. That is the difference between progress and revolution. Two of the most important steps forward in human history have been the emergence and consolidation of pure science and the granting of freedom to all qualified persons to follow their own bent in scientific research. It is for these things that the Society stands.

The defence of scientific freedom contradicted the whole weight of propaganda for the doctrine of narrowly directed research for economic ends, and at first the task of the small, newly formed Society might have seemed impossible. It was unable to get its case made public through most of the recognized channels of publicity in Britain. It had to approach its public by circular letter and memorandum in spite of the difficulties of paper shortage. The Society's efforts were not met by reasoned argument, but by obstruction, abuse, misrepresentation and ridicule. At the meeting of the Division of the British Association for the Social and International Relations of Science, held in London in September 1941, on "Science and World Order", no one was allowed to speak during the three days of the Conference except those previously chosen by the organisers, and the movement against pure science and freedom in science had free play. The meeting was extensively reported. Later on a speaker in a B.B.C. programme made an attack on the movement for freedom in science and its sponsors; and despite repeated requests by the Committee of the Society, the B.B.C. permitted no reply whatever.

In the face of misrepresentation and obstacles of every kind the Society was resolved to push its case forward. Small funds were gradually accumulated, stencilled communications were sent to an increasing number of people, and in 1945 the publication of the Society's "Occasional Pamphlets"[1] was begun. Books were published and lectures delivered. The results came slowly but surely, aided no doubt by the general reaction against Marxist doctrines. One distinguished research worker after another in various parts of the world began to rally to the cause. A glance through the present list of members will show that the Society is representative of the best scientific talent. Among the members are several Nobel prizewinners, as well as seventy-two fellows of the Royal Society. Certain distinguished philosophers and historians have formed a link with liberal-minded people over a wide field of culture. The Society is naturally stronger in Great Britain and the United States than elsewhere, but it has members in most parts of the world except the Soviet Union and its satellite countries. A special effort is now being made to increase its membership on the Continent of Europe.

The propaganda against pure science and against freedom in science was, we claim, brought to Britain from Russia, and it is essentially based on the Marxist doctrine that science is, and always has been, determined solely by economic pressure. Now, however, there has been a surprising change of front. Two distinguished Soviet physicists, Academicians P. L. Kapitza and A. Joffe, have been permitted to write articles expressing views that bear a striking resemblance to those held by the Society for Freedom in Science. The reason for this change of policy, and the degree to which it is actually affecting scientific life in the U.S.S.R., are not known. Perhaps it has been found empirically that totalitarianism in science does not work. Vast sums are said to have been spent on Soviet scientific research, but no one not blinded by political enthusiasm would compare Soviet work and progress in fundamental science with that achieved in Western Europe and in America. In certain fields of research, such as genetics, Soviet standards and criteria are almost incredibly perverse. Hudson and Richens, in a remarkably careful and dispassionate review of Soviet genetics[2], summarize their conclusions as follows:

"The school of genetics founded by Lysenko and Prezent in the Soviet Union, arose in 1935 and became dominant in Russia in 1940. It still flourishes, although perhaps less now than formerly. . . . Much of the scientific discourse of Lysenko's school is alogical, i.e. derives its conclusions not by logical argument from the facts, but by appeal to chosen authorities, by condemning views in opposition to these authorities, by analysing the presumed states of mind of its opponents, and by estimating the value of theories by their agronomic usefulness. . . . Lysenko's rejection of the data accumulated by Mendelian genetics during the past thirty years is obscurantist and reduces the value of his speculations."

It may be that the inevitably disastrous effect on practical results, in the long run, of such a travesty of sound scientific method is the cause of the change of policy apparent in the articles of Kapitza and Joffe. We are, however, ignorant of whether Soviet research workers are in fact now being given freedom to choose their own subjects or liberty to work in their own way. However that may be, communists in Britain have almost ceased to vilify the movement for freedom in science. Representatives of the Society were invited to address the British Association's Conference on Scientific Research and Industrial Planning, held in London in December 1945, and their remarks on behalf of pure science and freedom in science were received with almost no opposition. The whole atmosphere of the meeting was in complete contrast to that of September 1941.

The change of front of the scientific materialists has been startling. They are beginning to speak of the internal logic of science and of its cultural value, ideas prominent in the thought of those whom they were recently attacking. Meanwhile, there is a certain lag in the application of the new orientation, and some of those who are accustomed to take their opinions, whether wittingly or not, from communist sources, are still making propaganda for the central planning of scientific research.

One aspect of scientific freedom that has to be maintained is the freedom to communicate the results of research to all and sundry—internationally as well as within the limits of individual States. The construction of the atom bomb, because of its immense destructive capacity, has introduced a complication into this claim.

It has long been argued that the scientific employee of an industrial firm should have the right to publish any discoveries in pure science he may make in the course of his work. It is, however, very naturally contended that technical discoveries and inventions directly concerned with the firm's business and therefore involving its financial interests are properly kept secret at the employer's discretion. It is not, however, always easy to draw a satisfactory line between the two spheres. Almost parallel considerations, though with far more serious and far-reaching implications, seem to apply to nuclear research and its technological developments. Fundamental investigation of the structure of the atom clearly belongs to the realm of pure science. The keeping secret of its results in any country would disrupt the progress of atomic physics throughout the world. On the other hand, the technical developments of this fundamental work, directed to the making of atomic bombs, obviously are and will be the concern of national governments, until, of course, a supernational authority with both the will and the power to control such activities comes into existence. Under present conditions it is widely held among men of science that national governments are fully justified in keeping strictly secret the processes developed for the making of the bombs, since the American proposal for world-wide control has not been unanimously accepted. Communistic men of science, however, and their supporters, for reasons which are not obscure when their political affiliation is remembered, now demand the freedom of open and world-wide communication of all such technological developments—a 'freedom' clearly of relative disadvantage under existing international conditions to non-communist States in possession of the secret processes.

As in the case of those laboratories of industrial firms in which fundamental, as well as technological, research is carried on, it is not always perfectly clear just where the line between the two spheres should be drawn. In an attempt to disentangle the threads of conflicting opinion in this matter, the Society for Freedom in Science is conducting a questionary among its members on the subject of secrecy in nuclear physics. The answers should show where, in the opinion of those who have shown their interest in scientific freedom by joining the Society, the line should be drawn between freedom in scientific research on one hand and secrecy in technological matters of military importance on the other.

The violent attack on the old and well-established belief in the right to freedom in scientific research—an attack which, during the 'thirties, very nearly swept public opinion in Great Britain into a wholesale denial of that right—has turned attention to the psychological and philosophical foundations of that belief. A good deal of thought and study has been and is being devoted to the subject by members of the Society, and the results of some of it have been published. The field is wide, and much of it needs further clarification, for example, the relation of freedom in science to the concept of freedom at large. The present time, when the conflict between the opposite ideals of individualistic freedom and of the highly organised State with its tendency to totalitarian compulsion has reached a new degree of intensity, is particularly opportune for the active prosecution of these investigations.

[1] The whole set of Occasional Pamphlets may be obtained from the Secretary of the Society for Freedom in Science, University Museum, Oxford. 6s. 7d., including postage

[2] Hudson, P. S., and Richens, R. H "The New Genetics in the Soviet Union." Published by the School of Agriculture, Cambridge, 1946. 6s.

OBITUARIES

Sir Carruthers Beattie

Sir Carruthers Beattie, vice-chancellor and principal of the University of Cape Town during 1918–37, died in Cape Town on September 10.

John Carruthers Beattie was born in Dumfriesshire on November 21, 1866, and was educated at Edinburgh, where he was an 1851 Science Research Scholar and Vans Dunlop Scholar in physics, and afterwards at Munich, Berlin, Vienna and Glasgow. In 1897 he went to South Africa as professor of physics at the South Africa College, Cape Town, being one of a group of Scottish professors at the College who played a great part in the development of education in South Africa and raised the status of the South African College so that in 1918 it was reconstituted as the University of Cape Town. Beattie had been appointed principal of the College in 1917, and became in 1918 the first vice-chancellor and principal of the University. Under his administration the fine buildings of the University on the slopes of Table Mountain above Groote Schuur—probably the most magnificent site of any university in the British Empire—were planned and erected.

At the South African College the teaching duties of the professors were heavy and left little time for research. The most important scientific work undertaken by Beattie was the first magnetic survey of South Africa, carried out in collaboration with Prof. J. T. Morrison, of Stellenbosch, between 1898 and 1906. Beattie was granted leave of absence for one year in 1903 to continue the observations; apart from this, the observations were made during the various college vacations. More than four hundred stations were occupied from Agulhas in the south to the Victoria Falls in the north, and from Saldanha Bay in the west to Beira in the east. About twenty repeat stations were selected, at which observations were made at frequent intervals during the course of the survey for the determination of diurnal and secular variations. The results were published by the Royal Society in 1909 as "Report of a Magnetic Survey of South Africa" (235 pp.). Travelling in remote parts of South Africa at that time involved many discomforts, but in the course of it Beattie acquired an intimate knowledge of the country and its people.

Beattie was president of Section A of the South African Association for the Advancement of Science in 1910, in which year he was awarded the Medal of the Association. He became president of the Association in 1928. During 1905–6 he was president of the South African Philosophical Society and, after the formation of the Royal Society of South Africa, was for a time general secretary of the Society. He served on many Government committees and boards; he was a member of the Universities Statutes Commission, 1917; of the Scientific and Industrial Research Committee, 1907; of the Industries and Science Board, 1920; and of the Mining Industry Board, 1923. He was chairman of the Survey Commission in 1921. In 1920 he was created a knight bachelor.

The young University of Cape Town was fortunate in having Beattie as its principal for twenty years. Under his wise guidance a well-merited reputation, both in teaching and in research, was rapidly built up. He gained the respect and affection both of the students and of his colleagues. He was not an autocrat, but he could be firm when firmness was required. Patient, tactful, modest and approachable, he was an ideal principal.

In 1898 he married Elizabeth, third daughter of W. Paton, of Scarborough, and had a son, who was killed in the Second World War, and two daughters.

H. Spencer Jones

Prof. M. Camis

Alberto Mario Camis, formerly professor of physiology in the Universities of Bari, Parma and Bologna, died on August 28, at the age of sixty-eight. For some years heart disease had seriously impaired his physical health, but his intellectual powers were unabated. His death will be mourned by a large circle of Italian and foreign friends. He paid several visits to physiological laboratories in Great Britain, beginning in 1908, when, as a young graduate from Pisa, he worked at Cambridge with Langley and Barcroft and at Liverpool with Sherrington. A year or two later he edited volume 1 of the English translation of Luciani's "Human Physiology".

Camis' scientific work covered a wide field, with original contributions on metabolism, respiration, oxygen carriage, the pharmacology of muscle, physiological psychology, the labyrinth, autonomic reflexes, the spinal cord, and the cerebellum. A cultured writer, with a great sense of style and arrangement, he also wrote some admirable monographs. "Il meccanismo delle emozioni" (1919) and "La fisiologia dell' apparato vestibolare" (1928) are particularly noteworthy. His interests in other branches of science, especially physics, in philosophy, in history, in literature, and in art gave him a breadth of view which, combined with modesty, kindliness, tact and generosity, made him a delightful companion. His short, stocky figure, black beard, vivacious manner and twinkling eyes will be remembered by all who met him. Well versed in the physiological literature of five languages, he was a frequent attendant and contributor at the International Physiological Congresses, including the last at Zurich in 1938. Possibly his most important work was as a teacher and an encourager of young physiologists. He was an interesting and lucid lecturer who could interpret modern science to a lay audience.

An ardent patriot with a passionate devotion to Italy, Camis' later years were saddened by the misfortunes that befell his country. During the Italian campaign against Ethiopia, he spent nine months as a volunteer (aged fifty-six) in Somaliland studying the metabolism and diet of both natives and European immigrants. The results, which contradicted much of the teaching then current, were published by the Reale Accademia d'Italia in a slim volume entitled "Metabolismo basale ed alimentazione in Somalia" (1936). Yet little more than two years after his return to be professor at Bologna, he was pensioned by the Italian Government on account of a Semitic strain in his ancestry. Thereupon he followed an old inclination by becoming a Dominican monk, and in June 1939 was sent to Manila in the Philippines to join the staff of the Dominican University of St. Thomas there But his health would not stand a tropical climate and he returned after six months to the House of his Order at Bologna where, until 1943, he taught psychology in its seminary. For the remainder of the War he found a refuge from the Nazi domination of Italy in the Dominican University at Rome. After the liberation he was at once restored to his professorship, but ill-health prevented him from taking up the duties. He spent the last year of his life at the Convent of St. Dominic in Bologna, where he died. He was childless and a widower.

R. S. CREED

NEWS and VIEWS

Prof. E. D. Merrill

ON October 14, Dr. Elmer Drew Merrill, the well-known American botanist, was seventy years of age. To mark the occasion, special numbers of the *Journal of the Arnold Arboretum* (Harvard University) and of *Chronica Botanica*—in the latter case comprising a selection from Dr. Merrill's principal general writings, with a biography and bibliography, entitled "Merilliana"—have been issued. After holding posts in his *alma mater*, the University of Maine, and in the U.S. Department of Agriculture in Washington, Merrill lived and worked from 1902 until 1923 in the Philippines, first as botanist to the Bureau of Agriculture and later also to the Bureau of Forestry at Manila and eventually to the Philippine Bureau of Science. For several years, while holding the latter post, he was also head of the Department of Botany of the University of the Philippines, and in 1919 he became director of the Bureau of Science. During this period he wrote the "Flora of Manila" (1912), "An Interpretation of Rumphius's Herbarium Amboinense" (1917), "Species Blancoanæ" (1918), "A Bibliographic Enumeration of Bornean Plants" (1921), and the "Enumeration of Philippine Flowering Plants" (4 vols., 1923–26).

In 1924, Merrill left the Philippines to become dean of the College of Agriculture, and director of the Agricultural Experiment Station, of the University of California, being also director of the California Botanic Garden during 1927–29. The University of Maine conferred on him the honorary degree of D.Sc. in 1926. While in California he wrote "Plantæ Elmerianæ Borneënses", which appeared in 1929. In 1930 he became director-in-chief of the New York Botanic Garden. His important "Commentary on Loureiro's 'Flora Cochinchinensis' " was published in 1935. Since that date Dr. Merrill has held the post of professor of botany and administrator of botanical collections at Harvard University.

Philip Hill Chair of Biochemistry: Dr. Frank Dickens, F.R.S.

DR. F. DICKENS has been elected to the Philip Hill chair of experimental biochemistry tenable in the Courtauld Institute, London. This chair is an independent research post endowed by Mrs. Philip Hill in memory of her husband. Dr. Dickens took the Natural Sciences Tripos at Cambridge, and then spent two years in research work on pure organic chemistry under the late Sir Jocelyn Thorpe. In 1923 he became an assistant in the Biochemical Department (later the Courtauld Institute) of the Middlesex Hospital, and collaborated in the important work done there on insulin and sex hormones under the direction of Prof. E. C. Dodds. In 1927 he began his interesting work on tissue metabolism. In collaboration with the late Dr. Simer, he devised a method, which has been widely adopted, for the measurement of the true respiratory quotient of isolated animal tissues. This method has the advantage of being applicable in the presence of bicarbonate and carbon dioxide mixtures. By the use of this method he was able to show that there is a distinct difference in the metabolism of cancerous and most normal tissues. Dr. Dickens has also conducted research on tissue enzymes and the inhibitory effect on them of such substances as fluoride and iodoacetic acid. He has also obtained a certain amount of evidence to show that different paths of fermentation and oxidation may be available in cells and cell extracts from that usually followed, and which is known as the Embden–Meyerhof cycle. Dr. Dickens has also shown that tumours and embryonic tissues have an unusually high content of citric acid. A study of the distribution of citric acid in the body showed that about 1 per cent is contained in the hard substance of bone, and that this is very easily influenced by dietary and hormonal conditions, and may play an important part in calcium metabolism and bone formation. During 1943–44, at the request of the Medical Research Council, Dr. Dickens undertook special research on the toxic effects of oxygen on brain metabolism. Dr. Dickens has recently published four papers on the factors which control the carcinogenic action of certain hydrocarbons.

Zoology at University College, Hull: Prof. P. G. 'Espinasse

MR. P. G. 'ESPINASSE has become professor of zoology at University College, Hull. The College opened in October 1928, and the following year Mr. 'Espinasse, who had just graduated in the final honour school of zoology at Oxford, was appointed assistant lecturer in Prof. A. C Hardy's new department there. Two years later, the department was enlarged to one of Zoology and Oceanography, and Mr. 'Espinasse then became lecturer with enlarged responsibilities on the zoological side. In 1942, when Prof. Hardy was appointed to the regius chair of natural history at Aberdeen, the Department was split into two: one of zoology with Mr 'Espinasse as head (several departments in the College have non-professorial heads), and one of oceanography under Dr. C. E. Lucas. Zoology now again has a chair.

Prof. 'Espinasse is a versatile zoologist. While he is keenly interested in genetical theory and has written several papers on it, his researches have been mainly in the fields of micro-anatomy, embryology and the more physiological side of zoology. He worked out the development of the hypophysial portal system in man, has done much work on the action of the hormone œstrone and made important contributions to our knowledge of feather growth. While his skill as a microtomist has enriched his Department with beautiful series of histological and embryological preparations, he brings to his teaching something even more valuable: a love of discussion and a deep interest in the philosophy lying behind biological theory.

Centenary of Anæsthesia

On October 16, 1846, W. T. G. Morton, a dentist of Boston, Massachusetts, successfully administered ether to a printer named Gilbert Abbot during an operation, performed by J. C. Warren, for removal of a tumour from the neck; and this date has just been celebrated as the anniversary of the first practical application of anæsthesia for the purpose of abolishing pain during a surgical operation. An editorial article in the *British Medical Journal* (p. 546, Oct. 12, 1946), and six other articles in this issue, mark this centenary and give an epitome of our knowledge of anæsthetics. Dr. J. H. Burn and H. G. Epstein discuss theories of anæsthetic action, Dr. C. Langton Hewer discusses the remarkable recent advances in anæsthetic practice, A. C. King contributes an illustrated article on the history of anæsthetic apparatus, and Dr. E. Ashworth Underwood, director of the Wellcome Historical Medical Museum, discusses, in another illustrated article, the history of man's knowledge of the use of substances for the purpose of abolishing pain. This latter article, which is a valuable contribution to the history of medicine, begins with a reference to the neolithic age, when unknown substances may have been used for the purpose of abolishing pain during the operation of trephining the skull, which appears to have been performed quite often in those times. The controversies which raged around the work of Clarke, Wells, Morton, and the others, and their experiences with nitrous oxide and ether, are here discussed. Chloroform, first used by James Young Simpson in Edinburgh, came a year or so later. Thereafter, the stage was set for the remarkable subsequent development of what Sir William Osler has called "medicine's greatest single gift". These developments are the subject of an exhibition at the Wellcome Historical Museum, which was opened by Lord Moran on October 16.

In two of the articles in the *British Medical Journal* we are reminded of the close relationships which have always existed between medicine and literature. It was Oliver Wendell Holmes who suggested the terms 'anæsthesia' and 'anæsthetic'; and, when W. E. Henley, who had already lost one foot, had to have the other one amputated, he sought the aid of Lister and was under his care in the Edinburgh Old Infirmary during the years 1873–75. There, with the aid of what he has described as "the thick, sweet mystery of chloroform", he lost his other foot. In his "Hospital Verses", which are extensively quoted in this issue of the *British Medical Journal* in an article by Gunilla Liddle, he gives us a vivid picture, not only of Lister himself, but also of life in the wards of those days and of his own experiences in them. The centenary of the first practical use of anæsthetic substances has also been celebrated by a meeting, held on October 16, of the Royal Society of Medicine, and the *British Medical Bulletin* has a special issue devoted to anæsthetics which has the thoroughness and comprehensive scope characteristic of that journal.

Research in Chronic Rheumatism

As a result of investigations begun so long ago as 1922, the Medical Advisory Committee to the Ministry of Health recommended in 1945 that a number of diagnostic and research centres should be established for the study of chronic rheumatism and for the improvement of existing facilities for diagnosis and treatment; and it was proposed that the special centres should be located in university medical schools and teaching hospitals, where resources are available for a combined attack on the disease in all its forms. A rheumatism centre of the kind envisaged by the Ministry is to be established at the University of Manchester, with the assistance of a grant from the Nuffield Foundation of £100,000 spread over ten years. In broad outline it is proposed to establish a diagnostic and research centre at the teaching hospital, the Manchester Royal Infirmary, to deal with short-stay in-patients and out-patients. For long-stay in-patients there will also be a clinic at a base hospital near the centre, provided by the Manchester Public Health Committee, and a second base hospital, the Devonshire Royal Hospital at Buxton. At the base hospitals lengthy investigations will be carried out, and problems of rehabilitation and resettlement will be studied. At the centre the work will cover two main fields: the clinical, sociological and industrial aspects of the disease, and the fundamental study of the disease process by pathological, bacteriological and biochemical methods. The clinical work will be under the direction of a physician who will have the full co-operation of the Departments of Orthopædics and Physiotherapy of the Manchester Royal Infirmary as well as of the University Dental School. The social aspects of the disease, and its industrial implications, will be studied in co-operation with the University Department of Industrial Health. Fundamental research into the causes of diseases of the bones and joints will be under the direction of a whole-time pathologist who is an expert in this field.

National Laboratories in India

According to *The Statesman* (Calcutta and Delhi) of October 14, plans for four more national laboratories in India have been approved recently by the Governing Body of the Council of Scientific and Industrial Research.

Dr. Rajendra Prasad, Minister for Food and Agriculture, will lay the foundation stone of the Fuel Research Institute at Digwadih, near Dhanbad, on

November 17. The capital cost of the Institute is estimated at Rs. 14 lakhs. Mr. C. Rajagopalachari, Minister for Industries and Supplies and President of the Council of Scientific and Industrial Research, will lay the foundation stone of the National Metallurgical Laboratory at Jamshedpur on November 19 The initial capital expenditure on this Laboratory will be about Rs. 43 lakhs. The foundation stone of the National Physical Laboratory in Delhi will be laid by Pandit Jawaharlal Nehru, vice-president, new Central Government, on January 4, 1947, during the Indian Science Congress session. The estimated cost of this Laboratory is about Rs. 40 lakhs. Mr. B. G. Kher, Premier of Bombay, will lay the foundation stone of the National Chemical Laboratory at Poona some time towards the end of January 1947. The Bombay Government recently agreed to the location of this Laboratory in Poona and the transference to the Council of the land required for this purpose. This Laboratory is expected to cost Rs. 35 lakhs.

Manchester Federation of Scientific Societies

A FEDERATION of Scientific Societies has been formed in Manchester to enable the member societies to work together in matters of common interest. Pure and applied science are both strongly represented in the Federation, which will provide a meeting ground for workers in both academic and technological fields on the widest possible basis. The new body will not in any way seek to take over any of those activities which are the functions of the participating societies. It will, however, assist the executives of these societies in arranging their meetings and discussions to the greatest advantage of the members, many of whom belong to several societies. A calendar will be issued twice a year giving a list and dates of all meetings to be held by the societies in the Manchester district. The wider activities of the Federation are yet to be planned in detail. It is already interesting itself in the provision of post-graduate and refresher courses in science, and in this matter will seek the collaboration of the University of Manchester and the technical colleges. It will also pay attention to the problem of bringing scientific matters to public attention in popular form.

A need long felt by the Manchester scientific workers, and, indeed, by those of other big centres, including London, is for a scientific centre of their own. The home of the Manchester Literary and Philosophical Society in George Street, which frequently gave hospitality to other societies, was destroyed by enemy action in 1940. The scientific societies of Manchester need a building with a lecture theatre, meeting and committee rooms, and some provision for bodily refreshment, and it is hoped, by working together, that they may be able to satisfy this need. The principal scientific and professional societies are supporting the Federation, of which Dr. C. J. T. Cronshaw, a director of Imperial Chemical Industries, Ltd., has accepted an invitation to be the first president. Mr. J. T. Marsh, of Tootal Broadhurst Lee Co., Ltd., is the present chairman of the committee, and Dr. E. H. Rodd, of Imperial Chemical Industries, Ltd. (Dyestuffs Division), Blackley, is the honorary secretary.

Document Copying on Microfilm

THE photographic copying of documents and of published matter had attracted serious study in the United States for some years before war risks directed attention in Great Britain to its value. Recent conferences, such as that organised by the Association of Special Libraries and Information Bureaux (*Nature*, **156**, 24; 1945), have established clearly that photographic methods of reproduction will have many future parts to play in the publication and duplication of documents of all types, whether for business purposes or as part of the scientific information services (see *Nature*, **157**, 745; 1946 **158**, 353; 1946). 'Microfilm', that is, 35-mm. film coated with a fine-grained photographic emulsion and adapted to carry a series of images usually 24 mm. × 16 mm. or 24 mm. × 32 mm., is one of the media most commonly used for this purpose; but its application has undoubtedly been hindered by the limited supply of suitable apparatus for copying the original documents or for reading the film record. Potential users of microfilm will therefore be interested in the announcement of a new document-recording camera and (No. 3) microfilm reader and printer, made by Messrs. W. Watson and Sons, Ltd., of 313 High Holborn, London, W.C.1. The camera is a general-purpose machine which makes special provision for originals in book form and can tackle single documents up to 27 in. × 18 in.; it has a magazine holding 200 ft. of film and is designed for speedy operation, with interlocked controls. In the reader, the projected image is viewed by transmission through a diffusing screen 12 in. × 12 in. The activities of the British Standards Institution in this field should do much to stimulate the production and use of such equipment in Britain.

Science To-day

A WEEKLY science news-letter entitled *Science To-day*, edited by A. W. Haslett from 104 Clifton Hill, London, N.W.8, and offered for subscription at 30*s*. for 12 months (50 issues), is intended to provide brief but accurate notes on the main trends in contemporary science for both the scientific and non-scientific reader. It is intended to include also book reviews and notes on books. The first issue, dated October 10, consists of eight octavo pages and touches on fish migration, radar and surveying, the giant man of old Java (*Meganthropus paleojavanicus*), the international organisation of science, and lines of nuclear research on the atom. The latter article occupies three of the eight pages and is entitled "Atom Perspective"; it outlines in very general terms the structure of the atom, pointing out that we still know very little about the nucleus itself, which is the object of much current research.

Security in the Pacific Area

A REPORT by a Chatham House Study Group and issued by the Royal Institute of International Affairs, under the title "The Pattern of Pacific Security", points out that the region is not in itself an area which possesses natural defining boundaries by which the political cartographer can almost automatically draw regional frontiers on the map of security. While there are certain interests and problems which are mainly Pacific in character, most of the Powers concerned in the region are also Powers with substantial interests elsewhere. Accordingly, the Pacific Ocean must be treated as an area which cannot be considered apart from others, and the whole argument of the report reinforces the view that a system of security in the Pacific can be established only on the wider basis of world organisation, the mainstays for which are the United States, the British Commonwealth, the U.S.S.R. and China. The thirty-four specific conclusions of this study are set forth in its final chapter, following chapters in which the Pacific area is considered as a region, the main features of a design of security are outlined, and the position of each of the four major Powers is examined under the sub-title "A Speculative Appreciation of Certain Power Factors in the Pacific". British interests in the Pacific are discussed in a separate chapter, leading to the conclusion that Great Britain is a Power with so substantial a concern in the region that, in partnership with the Pacific Dominions of the British Commonwealth, she is bound to play a large part in the future history of that Ocean.

Sky Fantasia

ROBERT R. COLES, Hayden Planetarium, has an article with this title in *Sky and Telescope* of June, and among a number of celestial phenomena that present interesting and sometimes puzzling features is included the apparently greater diameter of the rising moon compared with the diameter when it has attained a higher altitude. Some text-books still repeat the old explanation, discarded many years ago, that the horizon moon is so situated that its size can be easily compared with terrestrial objects, but at higher altitudes we are deprived of these for comparison. Anyone can disprove this theory if he observes the moon near the horizon at sea, where no terrestrial objects are available for comparison. Yet the moon looks as large when rising or setting over the sea as it does when viewed on the land. Some years ago, Drs. E. G. Boring and A. H. Holway, two Harvard psychologists, after a series of experiments, concluded that the illusion is due to a physiological cause. It has been found that objects viewed straight ahead appear larger than do those of the same size in positions where the eye must be raised to see them. Although this theory is almost certainly the correct one, the basic causes are still somewhat of a mystery. The illusion can be observed in the constellations also, such as the Plough, which appears very much larger when low on the horizon than when high in the sky. Other groups of stars, like the Great Square of Pegasus, the Northern Cross, etc., exhibit the same phenomenon. An experiment which can be performed by anyone on some of these groups of stars, or preferably on the moon, will show that the old theory is incorrect. When the moon is near the horizon, gauge it between the thumb and forefinger and notice it shrinking; as the finger and thumb are separated it appears to swell again. This experiment is referred to elsewhere in the same issue of *Sky and Telescope*, and shows that the illusion is due to a physiological or psychological cause.

Surface-Active Agents

THE eight papers, together with the introductory address by M. L. Anson, presented at the two-day conference on 'Surface-Active Agents' held by the Physics and Chemistry Section of the New York Academy of Sciences in January 1945, have now been published (*Ann. New York Acad. Sci.*, 46, 347; 1946). Almost all the surface-active agents referred to were water-soluble substances which, even in small concentrations, lower the surface tension of water considerably. The properties of surface-active agents, how they are measured and how they are related to structure, were the topics discussed on the first day of the conference. Papers on these subjects were contributed by A. W Ralston, E. K. Fischer and D. M. Gans, D. Price, and L. Shedlovsky. On the second day, the applications of surface-active agents to biology, medicine and industry were dealt with, E. I. Valko and R. D. Hotchkiss lecturing on the biological and medical applications; M. H. Hassialis and R. R. Ackley on the industrial applications. In the introduction, it is pointed out that although surface-active agents have been known for some time as chemical substances, it is only relatively recently that they have become available as cheap commercial compounds. Many such agents have been prepared and many industrial applications discovered, mostly in industrial laboratories, but basic scientific work on pure substances has been very greatly neglected. Indeed, it was lack of sufficient knowledge of the properties of pure surface-active agents that prevented any useful theoretical discussion of the relation between structure and properties. The object of the conference was to stimulate interest and to put the understanding of surface-active agents and their applications on a better scientific basis; the publication of the proceedings of this conference on surface-active agents should be of considerable value in guiding workers in this field as to the choice of suitable research problems.

War-time Activity of the Leicester Museum and Art Gallery

THAT it is possible for a regional museum under active administration to fulfil and even increase its interests under the difficulties of war-time conditions has been amply proved by the Leicester City Museum and Art Gallery. The fortieth annual report (April 1, 1943–March 31, 1944; recently received) to the City Council shows, for example, that in that year the Geological Department, besides giving technical assistance in connexion with war-time industrial developments, provided special courses of instruction for members of the Forces; that the Department of Botany arranged topical exhibits in relation to war-time gardening, food values, medicinal herbs, etc., and that the Schools Service was extended to units of H.M. Forces stationed in the Leicester area, and to the development of children's clubs in art, science and drama. In addition, several special exhibitions of wide public interest were a prominent feature of the period. The R.A.F. "Wings for Victory" Exhibition drew 36,306 visitors, and the "City Planning" Exhibition, which was arranged in collaboration with various other Corporation Departments of Leicester City, drew 17,574 visitors. It is of interest to note that the general policy of the year was one directed at the "maintenance of public good spirits and morale". Towards this end, several other exhibitions of topical, art and domestic interest were arranged, while lectures and the weekly lunch-time concerts continued to be regular features. The bold and exploratory activity shown by the Leicester Museum throughout the war years has probably been watched with interest by other museum administrators. Many new methods of direct public appeal have been tried out and, judging from the attendance figures shown on p.15 of the present report, these have met with considerable success.

British Bryological Society

A MEETING of the British Bryological Society was held in London during September 27–28. After the meeting there was a dinner to celebrate the jubilee of the Society (founded in 1896 as the Moss Exchange Club), at which Sir Clive Forster-Cooper and Dr. John Ramsbottom were guests of honour. During the afternoon of September 27 the meeting was held (by kind permission of the director) in the Board Room of the Natural History Museum Prof T M. Harris, of the University of Reading, read a paper on the fossil liverwort *Naiadita*, and Miss Grace Wigglesworth, formerly of the University of Manchester, on reproduction in *Polytrichum commune*. Among the exhibits was part of the herbarium of the late Mr. H. N. Dixon, a former president of the Society. On September 28 there was an excursion to Eridge and Harrison's Rocks, near Tunbridge Wells, and the rich and interesting bryophyte flora of the sandstone was seen at its best ; *Pallavicinia Lyellii*, *Odontoschisma denudatum*, *Orthodontium gracile* and *Dicranum Scottianum* were among the interesting species found. In a stubble field near Eridge a rich flora of ephemeral bryophytes was seen, for which the wet season was doubtless responsible.

University of Leeds

At a meeting of the Council held on October 16, it was announced that Imperial Chemical Industries, Ltd., have given £2,000 to establish a research school in the Department of Biomolecular Structure, and the Rockefeller Foundation has given 10,000 dollars for research under the direction of Prof. W. T. Astbury for the current academic year. The Yorkshire Copper Works have given £300 for 1946 and 1947 for award of a scholarship to students of pure and applied science, preferably metallurgy.

Dr. F. C. Happold, reader in biochemistry, has been appointed professor of biochemistry as from August 1. The title of emeritus professor has been conferred upon Prof. J. H Jones, professor of economics, and Prof. W. P. Milne, professor of mathematics, on their retirement.

Lord Halifax will give the fifth Montague Burton Lecture on International Relations on February 20, 1947.

Earthquakes during August

On August 2 the earthquake near Copiapo in northern Chile had its epicentre near lat. 27° S , long. 70° W. The destructive Dominican Republic earthquake at 17h. 51m. 07s. G.M T. on August 4 had its epicentre near lat. 19·3° N., long. 69° W., which is nine miles east of the Samana Peninsula. Strong aftershocks from this epicentre took place at 13h 28m. 24s. G.M.T. on August 8 and 19h. 17·6m. G.M.T. on August 21. The earthquake of August 11 at 1h. 54·3m. G.M.T had its epicentre in the Solomon Islands near lat. 8° S., long. 155° E., whereas that of August 15 at 15h. 23·9m. G.M.T. had its epicentre near lat. 22° S , long. 170° E. All the above epicentres were determined by the U.S. Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association. The earthquakes of August 2, 8, 11 and 21, together with nine others, were registered by Mr. E. W. Pollard at Binstead, Isle of Wight.

Agricultural Research Council: Post-graduate Scholarship Awards

The Agricultural Research Council announces the following awards of post-graduate scholarships in agricultural science and in animal health, to take effect from the beginning of the academic year 1946. Such scholarships were last awarded in 1941, after which, as a war-time measure, they were discontinued. On this occasion the potential needs for specialist advisers in the National Agricultural Advisory Service were taken into account, as well as those of the research service. J. M Barry, University of Oxford, a three-year research scholarship in animal biochemistry ; J. R. S. Fincham, University of Cambridge, a three-year research scholarship in plant genetics ; A. Ibbotson, University of Birmingham, a three-year research scholarship in entomology ; D. J. R. Laurence, University of Cambridge, a three-year research scholarship in animal genetics ; B. C. Loughman, University College of Wales, Aberystwyth, a three-year research scholarship in biochemistry ; Miss M. T. Morton, University of Edinburgh, a one-year research scholarship in plant pathology , Miss U Parsons, University of Cambridge, a three-year research scholarship in animal physiology ; Miss J. N. Winfield, University of Leeds, a one-year research scholarship in plant physiology.

The Night Sky in November

Full moon occurs on Nov. 9d. 07h 10m , U.T., and new moon on Nov. 23d. 17h. 24m. The following conjunctions with the moon take place . Nov. 14d. 20h , Saturn 4° S. ; Nov. 22d. 03h., Jupiter 2° S. ; Nov. 24d. 18h., Mars 0·5° S. In addition to these conjunctions with the moon, the following conjunctions take place · Nov. 1d. 00h., Mercury in conjunction with Venus, Mercury 3·2° N. ; Nov. 6d. 08h., Venus in conjunction with Mars, Venus 5·2° S. ; Nov. 15d. 01h., Mercury in conjunction with Mars, Mercury 1·0° S The following occultations of stars brighter than magnitude 6 take place, the latitude of Greenwich being assumed : Nov. 2d 18h. 27 6m.. 33 Capr. (*D*) ; Nov. 5d. 22h. 11·0m., 30 Pisc. (*D*) ; Nov. 6d. 00h. 22·4m., 33 Pisc. (*D*) ; Nov. 7d. 19h 32 1m., ν Pisc. (*D*) ; Nov. 16d. 05h. 03·4m , η Leon. (*D*) ; Nov. 16d. 05h 39 6m., η Leon. (*R*) ; Nov. 18d. 04h. 06 6m , ν Virg. (*D*) ; Nov. 18d. 05h. 04·8m , ν Virg. (*R*). Mercury sets at 17h. 05m. on Nov. 1 and can be seen in the western sky after sunset. The planet is in inferior conjunction on Nov. 21. Venus is in inferior conjunction on Nov. 17 and can be seen towards the end of the month in the eastern sky, rising about 1h. 40m. before the sun. Mars and Jupiter are unfavourably placed for observation. Saturn rises at 22h. 25m. and 20h. 32m. at the beginning and end of the month respectively and is stationary on Nov. 21. The stellar magnitude of the planet is 0·4 throughout the month. There will be a partial eclipse of the sun on Nov. 23, invisible at Greenwich but visible over parts of Canada and America.

Announcements

Dr. Frank Hartley, secretary of the Therapeutic Research Corporation of Great Britain, Ltd., has been appointed manager of the Scientific Services Department of British Drug Houses, Ltd.

A series of discussion meetings on Wednesdays at 7.30 p.m. under the general title "The Outlook in . . " has been arranged by the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1. The first meeting (chairman, Dr. C. F. A. Pantin) will deal with biology (October 30), and the second (chairman, Prof. N. F. Mott) with physics (November 20).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Colour of Heavy Lead Silicate Glass

It has been generally accepted in the optical industry that heavy lead flint glasses are yellow in colour. The Schott catalogue[1] on Jena optical glasses marks most of the heavy flints they produce as being yellow, and it is further pointed out that noticeable yellow colour would result even by using chemically pure materials. The question whether the yellow colour is intrinsic to the composition or is due to the presence of colouring oxides as impurities has been the concern of many ceramists and glass technologists[2,3]. Based on the fact that for heavy lead glasses the colour of the glass becomes browner as the temperature is raised, it was considered probable that the yellow tinge at room temperature might be due to the residual effect of thermal broadening and shifting of the characteristic ultra-violet absorption band towards the longer wave-lengths of the spectrum. Thus it has been suggested by several workers as being due to the thermal dissociation of lead silicate into unbonded lead oxide[2]. W. Weyl[3] further suggested, on the modern view, that the deepening in colour might be due to the influence of the PbO bond in the glassy structure. On the other hand, it is also well known that colouring oxides such as iron, copper, etc., all produce more intense colours in heavy lead glasses than in ordinary lead-free glasses. In fact it is not impossible that the thermal deepening in colour is partly due to the presence of such oxides.

In relation to this problem, particular mention should be made of the work carried out by Sir Herbert Jackson[4] and his colleagues Smith and Cooke[5] of the British Scientific Instrument Research Association early in 1924, who not only stressed the heavy colouring effect of iron oxide in heavy lead glasses, but also, by using raw materials containing less than 0.00005 per cent iron oxide, succeeded in producing a glass of refractive index 1.83, density 5.05, completely free from colour. But for glasses melted in platinum, of densities varying from 6.06 to 7.05 (corresponding to indices of refraction from 1.924 to 2.09), the colour deepened progressively from faint yellow to orange when viewed through 1 cm. thickness. They also mentioned that chromium oxide coloured the glass intensely.

Recently, we have reinvestigated the colouring effect of iron oxide, as well as chromium oxide and copper oxide, in heavy lead silicate glasses. For glass of refractive index 1.915, iron oxide contributed a yellow colour, copper oxide green, and chromium oxide yellow, when viewed through 2 cm. thickness at concentrations of 0.01, 0.005 and 0.0005 per cent respectively. Spectrophotometric measurements indicated that the colouring effect of each oxide was proportional to its concentration over the range studied. Comparatively, the colouring power for iron oxide, copper oxide and chromium oxide was approximately in the ratio 1 : 2 : 40 respectively. Chromium oxide thus appeared by far the most powerful agent which could render a noticeable tint at a concentration so low as 0.00002 per cent at 2 cm. thickness.

We were naturally interested in producing a glass as free from colour as possible. For raw materials pure lead nitrate was prepared by dissolving spectrum pure lead in nitric acid, and precipitated silica was obtained by distillation from sodium silicofluoride and sulphuric acid. By sintering the batch and melting in a pure thoria crucible, a glass was obtained free from any noticeable tint through 5 cm. thickness, the refractive index being 1.90. It thus appeared that up to the index 1.90, heavy lead silicate glass could still be colourless. We found also that by melting in platinum, the attack—though not detrimental to the crucible—contributed appreciable colour to the glass. Details of the present results are to be published elsewhere.

We wish to acknowledge the courtesy of the British Scientific Instrument Research Association in allowing us to mention the results quoted above. The experiments were carried out by the staff of these laboratories working as a team.

W. M. HAMPTON
(Technical Director)

Chance Brothers Limited,
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Sept. 20.

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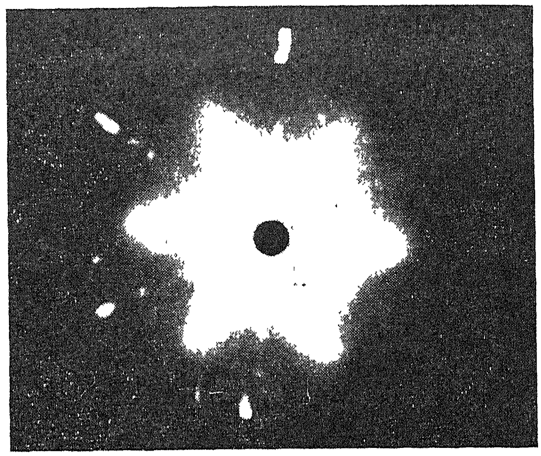
[2] Mohl, H., and Lehmann, N., *Sprechsaal*, **62**, 463 (1929).
[3] Weyl, W., *J. Soc. Glass Tech.*, **27**, 289 (1943).
[4] Jackson, Sir Herbert, *Nature*, **120**, 264 and 301 (1927).
[5] Report 27, British Scientific Instrument Research Association, 1924, Report to Members.

Statistical Structure of Ice and of Ammonium Fluoride

Booth[1] has pointed out that if a strong diffuse streak of X-ray scattering connects two regions in the reciprocal lattice of a centro-symmetrical crystal, then the structure factors corresponding to those two regions must have the same sign, and he has suggested that this may be helpful in overcoming the X-ray crystallographer's bugbear: determination of phase. This argument is quite sound, it seems to me, if the diffuse scattering is due to displacement or vibration of those atoms the diffraction of which is mainly responsible for the reinforcing scattered waves which give the Bragg reflexions; and in crystals where this is the case, the method should be very useful.

In ice, however, where the contribution of the centro-symmetrically arranged oxygen atoms certainly decides the phase of the scattered waves, strong diffuse streaks do connect regions where the structure factors are *not* of the same sign; moreover, the diffuse pattern is more symmetrical than could possibly be the case if Booth's rule were satisfied. The diffuse pattern is very strong near 0° C., but it has almost disappeared at − 183° C., although it is still easily visible



LAUE PHOTOGRAPH OF ICE AT − 2° C., SHOWING STRONG DIFFUSE PATTERN

on the Laue photograph (published by Barnes in 1929[2]) of ice at − 78.5° C. It is, therefore, of thermal origin; but comparison with theory shows that it cannot, in the main, be due to acoustical vibrations, because no combination of any elastic constants whatever could give the star-shaped pattern found.

Since the diffuse streaks cannot be due to the oxygen atoms in ice, they must presumably be due to strong vibratory movements of the hydrogen nuclei, which may still, according to Bernal and Fowler[3], retain about 0.5 electrons each.

Bernal and Fowler have also pointed out that if ice is molecular (and its Raman and infra-red spectra prove that it is) then the unit cell cannot be so small as that given by X-rays. It must be at least three times as large. But Pauling[4] has shown from the experimental value of the residual entropy that the water molecules in ice cannot have the definite orientations which would permit a unique crystalline configuration such as that suggested by Bernal and Fowler. In fact, there are $(3/2)^N$ permitted molecular configurations (N is Avogadro's number) of a mole of ice. The change from one configuration to another, Pauling suggests, would take place by group movements of hydrogen nuclei, each of which would move from the neighbourhood of one oxygen to that of its next oxygen neighbour (or possibly by a rotation of the water molecules).

The diffuse X-ray scattering indicates that this is so, in which case, the small unit cell found by X-ray structure analysis would indeed be the true *statistical* unit cell, although the instantaneous configuration would be more complex and might not even be strictly periodic. It might well be that even at very low temperatures indeed the apparent unit cell would still be small because different molecular configurations would be frozen in, in different parts of a single crystal. Such time- or space-averaged statistical structures are becoming increasingly familiar to X-ray crystallographers.

A similar star-shaped diffuse pattern is observed for ammonium fluoride (isomorphous with ordinary ice), in which, therefore, similar strong vibratory movements of the hydrogen atoms must be taking place. Although, undoubtedly, the H—F bond is much more ionic in character than the N—H bond, yet even in this case a resonance between the structures N H F−, N− H+ F− and N− H F seems probable.

I am indebted to Miss D. J. Smith and Mr. P. G. Owston for experimental assistance.

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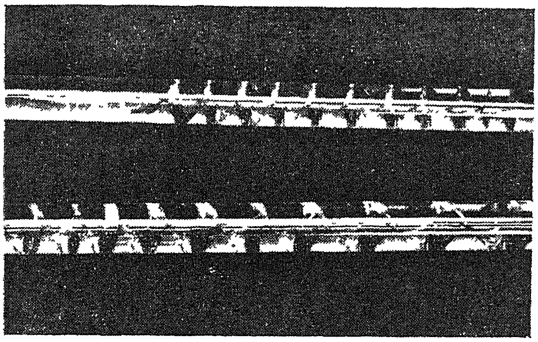
[2] Barnes, W. H., *Proc. Roy. Soc.*, A, **125**, 670 (1929).
[3] Bernal, J. D., and Fowler, R. H., *J. Chem. Phys.*, **1**, 515 (1933).
[4] Pauling, L., "The Nature of the Chemical Bond" (Cornell University Press, 1945), 302.

Spiral Cracks in Glass Tubes*

Anyone dropping very hot glass tubing into cold water expects it to shatter. However, one does not expect it to shatter in a simple geometric pattern such as a spiral. I was surprised to observe such fracture, and to find that the spiral pattern is a preferred one. (The experiments were limited to 'Pyrex' glass, since soda glass was not available.)

A method of making these spiral cracks in 'Pyrex' tubing is the following: one lays one end of a stick of thick-walled capillary tubing on a hot plate. (A tube 7 mm. in diameter with a 1.5 mm. hole is a suitable size. A suitable hot plate is one having 1 kW. rating and a flat metal top 8 in. in diameter. The temperature of the hot plate was probably between 500° and 600° C., which is well below the 'strain-point' of 'Pyrex'. Heating the glass essentially from one side seems to promote spiral fracture.) A rubber blow-tube is slipped over the cool end of the glass tube, and then, while blowing air through the glass tube to keep water out of the capillary, one plunges the hot glass endwise into a bucket of water. The spiral fracture shown in the photograph results.

It was noticed that quenching from a high temperature gives rise


A

B

to a close spiral (Fig. *A*) and from a lower temperature a coarser spiral. A temperature gradient along the tube, made by touching one end of the tube to the hot plate and raising the other end slightly, results in a tapered spiral (Fig *B*). Too low temperature of heating before quenching gives a straight line or a wavy line fracture, while a too high temperature may cause short segments of the tube to be broken off. Left- and right-handed spirals are equally prevalent even in sections of the same tube

As a result of this heating and quenching, one may qualitatively describe the cracking of the glass as follows Well-annealed glass is strain-free when uniformly heated When such hot glass is suddenly plunged for a moment into water, the outside of the glass in contact with the water is chilled and undergoes tensional stress while the hot interior is compressed. Under the tensional stress, any minute fissure in the surface of the glass (usually at the end) may open and start a crack which travels over the surface of the glass and relieves the tensional strain. Prolonged cooling deepens the crack and causes a secondary crack to form which is continuous with the first and completes the spiral rupture. The spiral pattern is apparently the one that gives most strain release in the circumstances.

The simplicity of this form of fracture would indicate that the related mathematical problem in heat transfer and stress-strain relations might have a relatively simple solution

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Sept. 22.

* Contribution No 4 from the Applied Physics Laboratory of The Johns Hopkins University, the work described here was done in connexion with Contract NOrd 7386 with the U.S. Naval Bureau of Ordnance

Electron Accelerator of Synchrotron Type

WHILE accelerators of the cyclotron type have facilitated the production of energetic particles, they are, as yet, beyond the financial means of a great many laboratories. Moreover, the attainment of energies nearing the range of a thousand million electron-volts is associated with considerable difficulty and expense if attempted by current methods. It is suggested that, by using the synchrotron principle[1] together with a magnet of unusual design, these objections might be overcome.

It can be shown that the energy and radius of an equilibrium orbit in the synchrotron are determined by

$$E = \sqrt{(Bcer)^2 + E_0^2}, \quad . \quad . \quad . \quad (1)$$

$$r = \sqrt{(c/\omega)^2 - (E_0/Bce)^2}, \quad . \quad . \quad . \quad (2)$$

where E is equilibrium energy (total), E_0 is rest mass energy; r is radius of equilibrium orbit, B is magnetic flux density at orbit, ω is angular velocity of 'dee' voltage, e is charge on particle; c is velocity of light

Equation (1) shows that the equilibrium energy may be increased by increasing B—as observed by McMillan Equation (2) indicates that the equilibrium radius may be maintained constant by causing a suitable increase in ω as the value of B is raised.

Rendering the equilibrium radius constant in this way allows the use of a magnet of simplified design. The most convenient form of magnet is a laminated steel bobbin, the depth and width of which are small compared with its diameter. The vacuum chamber and energizing coil lie between the cheeks of the bobbin, the coil having the smaller diameter. Ring-shaped pole pieces are fastened to the cheeks in the region of the vacuum chamber so that the distribution of the field may be controlled The usual magnet yoke is eliminated in this way and, since it is unnecessary to increase the depth and width of the bobbin in direct proportion to the diameter, the saving in material and the efficiency are greater for larger accelerators. The magnet of the small (13 Mev.) electron accelerator which is being built at this University weighs less than 200 lb

While some difficulty is associated with the required change in ω, no insuperable difficulty is anticipated. It is certainly possible to produce a change large enough to accelerate electrons to high energy from a reasonable injection energy. It is thought that, where the final velocity of an accelerated particle is several times the initial value, the difficulty of producing a correspondingly large frequency change might be circumvented by the use of 'harmonic orbits' The fact that a particle can be accelerated when its period is an integral multiple of the period of the 'dee' voltage suggests that a large change in velocity may be accommodated by repeatedly changing ω over a 2 1 range The frequency is increased slowly and decreased very rapidly, several such cycles occurring as the magnetic field increases to its maximum We hope to verify this when our accelerator is placed in operation

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Sept 10.

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Reaction Velocity at Phase Limits and its Dependence on the Frequency of the Vibration of the Lattice

IN studying reactions between two solid phases, it is found that the reaction velocity in systems such as MgO/Ag_2SO_4[1], MgO/Ag_3PO_4[1], $MgO/Mg_2P_2O_7$[2] and $MgO/MgSiO_3$[3] is not determined by the diffusion process through the reaction products, but by reactions at one of the phase limits. The reaction velocity is independent of the thickness of the layer of reaction product and changes with temperature according to the exponential equation

$$dm/dt = C.\exp(-q/RT).$$

The reaction velocity of the systems magnesium oxide/silver salt is at a certain temperature about a million times as great as in the system $MgO/Mg_2P_2O_7$, and in the latter is considerably greater than in the system $MgO/MgSiO_3$, but this difference is dependent only on the great differences in energy of activation On the other hand, the constant C for all the four systems is practically the same.

System	q kcal.	C gm.-mol MgO cm.$^{-2}$ sec.$^{-1}$
MgO/Ag_2SO_4	61	2.0×10^5
MgO/Ag_3PO_4	61	2.0×10^5
$MgO/Mg_2P_2O_7$	82	2.1×10^5
$MgO/MgSiO_3$	112	1.0×10^5

Since the specific gravity of magnesium oxide is about 3 2, the constant C corresponds to a yield of 5×10^{13}–1.0×10^{14} molecule layers per second: the linear reaction velocity in cm. sec^{-1} is in the systems investigated proportional to the product of atom frequency and lattice spacing of the oxide[4].

When investigating the thermal decomposition of zinc oxide we have arrived at an analogous result[5]

$$dx/dt = 1.2 \times 10^{12} \exp(-94{,}000/RT).$$

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Sept 2.

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[3] Unpublished results
[4] cf Polanyi, M, and Wigner, E., *Z phys. Chem.*, A, **139**, 439 (1928).
[5] Bengtson, B., and Jagitsch, R, *Ark kemi, min o geol* (Stockholm), in the press.

An Extension of the Lens-Mirror System of Maksutov

THE lens-mirror system described by D. D. Maksutov[1], in which the aberrations of a spherical mirror are corrected by a single spherical-surfaced meniscus lens, while eminently suitable for telescope objectives of moderate relative aperture, combining the coma correction of the refractor with a virtual absence of secondary spectrum, suffers from two sets of limitations which restrict its possible application in other fields. In the first place, the higher order spherical aberration is too great to yield the highest resolving power at very great relative apertures (except at very small focal lengths). Secondly, since the system has only three variables apart from meniscus thickness, the oblique aberrations other than coma cannot be corrected simultaneously with spherical aberration and axial achromatism, thus restricting its use over large angular fields. The former limitation may be reduced by increased thickness of the meniscus, but this necessarily involves larger uncorrected oblique aberrations.

D. G. Hawkins and E. H. Linfoot[2] recently described in *Nature* a combination of a concentric Maksutov meniscus and a doublet Schmidt aspheric plate which overcomes these limitations. Similar results may be obtained without the use of non-spherical curves by the use of two spherical-surfaced meniscus lenses, one concave and one convex to the mirror. In such a system, conserving the secondary-spectrum correction of the Maksutov system, the higher order spherical aberration is very considerably reduced, the first order oblique aberrations may be completely corrected, and the meniscus thicknesses may be increased with further considerable gain in axial correction, without detriment to the oblique imagery. Moreover, the variables of the system being more than are required to fulfil the Seidel conditions, a form of lens may be chosen reducing the higher order oblique aberrations to negligible size: this is possible in these two-meniscus systems by adopting a form in which the effective stop lies between the centres of curvature of the two surfaces of each meniscus (which are close together), thus reducing the angles of incidence of a principal ray to very small values. This is not possible in the Maksutov systems, since in these coma correction requires that the stop should be relatively far removed from the meniscus centres of curvature.

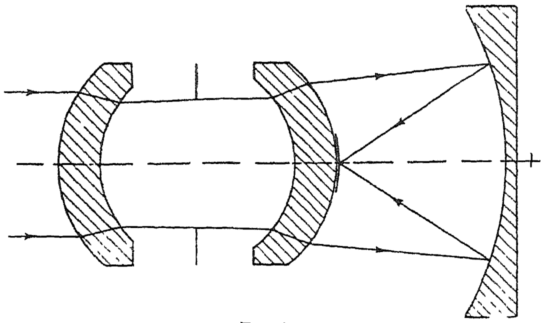

Fig. 1

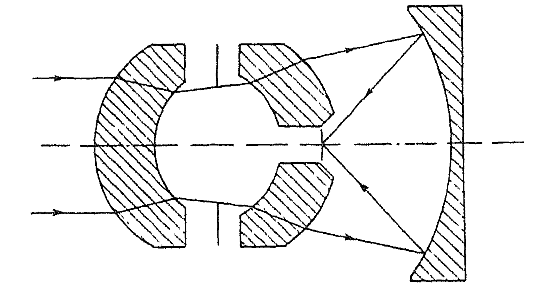

Fig. 2

In the $F/1.0$ lens shown in Fig. 1, the oblique aberrations are thus reduced to a level where the unvignetted oblique imagery over 24° of field is identical with the axial to six-figure ray tracing accuracy, the axial spherical aberration producing a departure of the emergent wave-front from sphericity of a quarter of a wave-length per 25 mm. of focal length. The thicker meniscus form shown in Fig. 2, which has similar oblique corrections, reduces the axial aberration to half this value for an aperture of $F/1.0$ and, for an aperture of $F/0.7$, the wave-front aberration is about one wave-length per 25 mm. of focal length.

It is hoped that a fuller report of the actual designs, and further modifications, will be published elsewhere.

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[1] Maksutov, D. D., *J. Opt. Soc. Amer.*, **34**, 270 (1944).
[2] Hawkins, D. G., and Linfoot, E. H., *Nature*, **157**, 445 (1946); *Mon. Not. Roy. Astro. Soc.*, **105**, 334 (1945).

Effect of Pressure on Crystal Growth

I NOTE, in the account of Mr. F. R. Himsworth's paper before the Roads and Building Materials Group of the Society of Chemical Industry, a comment[1] that "there are theoretical difficulties in the assumption that growth of a crystal in a not completely confined space can exert a pressure, and more direct experimental proof of such a process is still required".

It is well known to crystallographers that when a crystal grows at rest on the bottom of a vessel, growth on the contact face is slowed but not totally inhibited—and growth on the contact face involves a force lifting the crystal against its own weight. Attention should also be directed to a paper by G. A. Russell[2] on crystal growth and solution under local stress, and to the preliminary quantitative measurements of A. Shubnikov[3]. Shubnikov found a growing crystal of alum exerted a force of 0·89 gm./cm.^{2}.

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[1] *Nature*, **158**, 13 (1946).
[2] *Amer. Min.*, **20**, 733 (1935).
[3] *Z. Krist.*, **88**, 466 (1934). *Trav. Inst. Lomonosoff Acad. Sci. URSS.*, No. 6 (Sér. cryst.), 17 (1935).

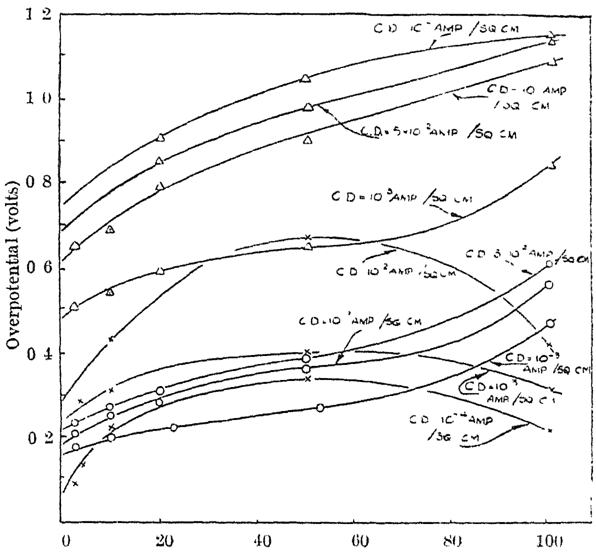
THE comment to which Dr. Hey refers was intended to question if any appreciable pressure could be exerted by a growing crystal under the conditions cited. The forces quoted by Dr. Hey are small, though sufficient to raise a crystal against its own weight. The general problem of the effect of uni-directional stress on solubility has been discussed by various authors, and reference may be made in particular to the work of R. W. Goranson[1]. Under a compressive stress the solubility of the stressed face is increased more than that of the unstressed face, and continued growth of the stressed face must depend on some degree of supersaturation of the liquid. There does not appear to be any experimental proof of the exertion of appreciable pressures by growth of a crystal in a not completely confined space.

F. M. L.

[1] *J. Chem. Phys.*, **8**, (4), 323 (1940).

Effect of the Solvent on Hydrogen Overpotential

THE recent work of Hickling and Salt[1] in proposing a new version of the atomic hydrogen theory of overpotential has served to increase interest in experiments which offer critical evidence differentiating between the theories concerning the various processes regarded as the slow stage in overpotential. Little work has been done on the influence of the solvent on overpotential[2], and knowledge of this latter aspect would seem of use in the connexion mentioned above. Thus alteration of the solvent medium at once affects the entities discharged at the cathode, the interfacial tensions at the metal – solution and solution – gas interfaces and adsorption on the cathode. Each of these factors has been regarded as having considerable importance in hydrogen overpotential theory[3].



HYDROGEN OVERPOTENTIAL IN ACETIC ACID – WATER MIXTURES. VARIATION WITH COMPOSITION OF SOLUTION. △, LEAD CATHODE; ○, COPPER CATHODE; ×, NICKEL CATHODE.

Measurements of hydrogen overpotential have been made, mostly at high current densities (10^{-3} – 10^{-1} amp./sq. cm.) on lead, copper and nickel cathodes in a number of normal solutions of hydrogen chloride in methyl and ethyl alcohols and glycol, formic and acetic acids, diethyl ether and dioxane, and, where practicable, in the corresponding aqueous – non-aqueous mixtures containing these solvents. Typical results are shown in the accompanying figure. The solvent effect was found to be marked in some systems, amounting to a decrease of 0.5 volt for overpotential on lead in 100 per cent ethyl alcoholic solution. The overpotential on lead is generally less in non-aqueous than in aqueous solutions, and sometimes has a tendency to pass through well-defined maxima and minima at intermediate compositions.

On nickel cathodes there is usually a less marked solvent effect of a different type, and more complex variations tend to occur. The behaviour of copper cathodes resembles that of lead.

Gurney's expression[4] for the interface potential Vc at a working cathode contains a solvation energy term, but it would seem that the theory indicates an independence of the overpotential on the solvation energy, and therefore the influence of the solvent, because this term is eliminated when the expression for the reversible hydrogen electrode potential is subtracted from Vc. Eyring, Glasstone and Laidler's theory[5] accords with the lowering observed in some solvent – water mixtures, but is in disagreement with experiment when compared with the increased value of the overpotential on lead observed in some methyl and ethyl alcohol – water mixtures, and it is difficult to understand upon its basis why the solvent effect is a function of cathode material. (This latter objection appears to apply also to all versions of the slow discharge theories.) It seems that a treatment of the solvent effect on overpotential from an atomic hydrogen viewpoint, in which account is taken of the influence of the properties of the cathode upon its power for adsorption of the solvent might prove to be a possible basis of the interpretation of the results. A detailed report of this work will be published elsewhere.

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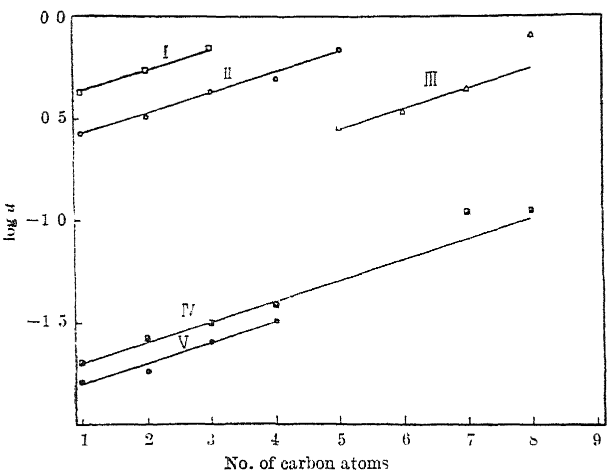
Biological Activity of Compounds in Homologous Series

WHEN a biological action may be attributed to a physical mechanism, the equi-effective (equi-toxic, equi-narcotic, etc) concentrations of compounds in homologous series decrease very rapidly as the number of carbon atoms increases the molar concentration required to produce a given effect is approximately one third that of the preceding member, that is, the logarithm of the equi-effective concentration is a linear function of the number of carbon atoms. This generalization holds fairly well over a wide range of biological actions and homologous series, and it has been used to predict the activity of higher members of a series from results obtained with the lower homologues[1] The decrease in equi-effective concentration does not however, proceed indefinitely. As the homologous series is ascended, a member is reached which has the maximum activity, and the higher members are either entirely inactive or have very greatly reduced activity The position of this 'cut-off' depends on the homologous series, on the nature of the biological action being investigated, and even on the relative resistance of different strains of the same organism[2]. It is the purpose of this communication to suggest that the position of this 'cut-off' can be approximately predicted from the results obtained with lower homologues.

Ferguson[3] has suggested the (thermodynamic) activity as defined by G N. Lewis[4], instead of concentration, as a more useful index of biological activity. He has shown that, as a homologous series is ascended, the equi-effective thermodynamic activity changes much more slowly than does the corresponding equi-effective concentration. Moreover, while the concentration decreases, the thermodynamic activity, in general, slowly increases (see Tables 2, 3 and 4 of ref 3) This means that, although a rapidly diminishing concentration suffices to produce a given biological effect, a slowly increasing thermodynamic activity is needed Since by definition the thermodynamic activity cannot exceed unity (which occurs when the solution becomes saturated), the member of the homologous series for which the thermodynamic activity approaches unity possesses the maximum biological activity. After that member the 'cut-off' occurs, for a more than saturated solution would be needed to produce a given effect.



RELATIONSHIP BETWEEN THE LOGARITHM OF THE THERMODYNAMIC ACTIVITY REQUIRED FOR EQUI-EFFECTIVE BIOLOGICAL ACTION, AND THE LENGTH OF CARBON CHAIN

I Alkyl acetates: hæmolysis of ox blood.
II Alcohols. bactericidal action, *Staphylococcus aureus.*
III. Paraffin hydrocarbons narcosis of mice.
IV. Alcohols; inhibition of development of sea-urchin eggs
V. Alcohols: tadpole narcosis

It can be seen from the accompanying graph that for every additional CH_2 group in any homologous series there is an approximately constant increase in the logarithm of the critical thermodynamic activity which just suffices to produce a given effect. This increase is followed fairly closely in the eight series calculated by Ferguson[3], and in four additional ones which I have calculated from published biological results[5,6]. The average increase in log a for every additional CH_2 group is 0 10 The divergencies do not appear to be greater than the probable error, although the lower alcohols are sometimes, but not always, more active than could be predicted from the higher homologues. If, therefore, the logarithm of this critical thermodynamic activity can be calculated from the biological results obtained with the lower members, a straight line, drawn through these points at the average slope, will, when produced, give the member for which log a approaches zero In other words, this will give the member which will exert the same biological action as the lower members at a thermodynamic activity approaching unity From Curve I, one can predict that, whereas butyl acetate will probably be active in about one third the molar concentration required in the case of propyl acetate, amyl acetate will probably be inactive under the same conditions. In fact, butyl acetate is active at about the required concentration[7], but no results were reported for amyl acetate. From Curve II one can expect heptyl alcohol to be inactive against *Staphylococcus aureus*, and hexyl alcohol probably active. Tilley and Schaffer[5] found the 'cut-off' to occur with hexyl alcohol. Against less resistant organisms (*B. typhosus*) the 'cut-off' does not occur until later in the series. There are few biological results available with homologous series extending past octyl Clark's[8] results on the depression of the frog's heart are too approximate for accurate prediction, for all the molar concentrations above C_7 are given to one significant figure only However, using the results of the three lower members, one can predict that the 'cut-off should appear with hexadecyl alcohol Clark found it to occur with tetradecyl alcohol

It is a pleasure to thank Dr J C Speakman for advice and criticism

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Effect of Electrolytes on Cation-active Detergents

IT is well known that the addition of divalent metallic ions greatly enhances the surface-active properties of anion-active detergents, and it was suggested by Robinson[1] that a similar effect should occur on adding divalent anions to cation-active substances This was confirmed by Powney and Addison[2] for the addition of sulphate ions to dodecyl pyridinium chloride.

We have recently investigated the effect of the addition of sodium sulphate to several such compounds, including cetyl trimethyl ammonium bromide. It was found that in 0 01 N sodium sulphate, a concentration of 0 0025 per cent of this substance produced the maximum lowering of surface tension, whereas in the absence of added electrolyte a concentration of 0 015 per cent was necessary in order to produce the same effect.

Since cetyl trimethyl ammonium bromide is used as an antiseptic, tests were carried out to determine whether the bactericidal and penetrating properties of very dilute solutions would be improved by the addition of sodium sulphate. The test organism used was a pyogenic strain of *Staphylococcus aureus* supplied by the National Collection of Type Cultures, and it was found that by the addition of extremely small quantities of sodium sulphate the concentration of cetyl trimethyl ammonium bromide required to produce a given effect could be halved.

We would like to thank the Director of Research for his advice and criticism in this work, and the Council of the British Launderers' Research Association for permission to publish this note

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[1] *Nature*, 139, 626 (1937).
[2] *Trans Farad Soc.*, **33**, 1253 (1937)

Reduction by Dissolving Metals

IN order to draw general conclusions as to the mechanism of reduction by dissolving metals from the data obtained in the course of a number of reductions by sodium and alcohol in liquid ammonia[1,2,3], it is necessary to determine more precisely the role of the solvent. That its use is not essential for the hydrogenation of benzene derivatives to $\alpha\delta$-dihydro-compounds is shown by the fact that anisole, dimethylaniline or *m*-tolyl methyl ether when treated in boiling light petroleum (b p 100–120°) with potassium and the equivalent amount of ethyl, or better, *iso*propyl alcohol, gave the dihydro-derivatives already obtained[1,3]. This was shown by conversion to the 2 : 4-dinitrophenylhydrazone of Δ^3-*cyclo*hexenone, m p 133–134°, convertible by acid to the derivative of Δ^2-*cyclo*hexenone, m.p 167°, and in the last case by preparation of the 2 . 4-dinitrophenylhydrazone of 3-methyl-Δ^2-*cyclo*hexenone, m p. 174° [3]. The method has little practical value because of the small yields, except perhaps with compounds insoluble in ammonia, but it demonstrates that the solvent does not affect the nature of the products.

The favourable influence of ammonia is probably due partly to its ability to dissolve alkali metals, but more to its ability to stabilize the divalent anions formed as intermediates[2] (compare its use for the preparation of alkali salts of very weak acids such as unsaturated hydrocarbons[4]). Also, in contrast to reduction in pure alcohols, both these methods employ much lower proportions of alcohol to substrate, thus increasing the efficiency of the metal by decreasing the tendency to form hydrogen gas

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[2] Birch, *J. Chem. Soc.*, 809 (1945).
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The Perfect Buffer

CONSIDER a solution containing (*a*) equivalents of a weak acid, HA, and (*b*) equivalents of a strong base. For this to be a perfect buffer it may presumably be stated that the rate of change of *p*H with added acid or base must be a minimum; that is, $dp\text{H}/db$ is to be a minimum, or $d^2p\text{H}/db^2 = 0$. For a weak acid: $C_{\text{H}} \cdot C_{\text{A}}/C_{\text{HA}} = k$. Since the salt will be practically 100 per cent ionized and the acid negligibly so, it follows that $C_{\text{A}} = b$, and $C_{\text{HA}} = (a - b)$. $\therefore C_{\text{H}} \cdot b/(a - b) = k$ (1). By taking natural logarithms and differentiating twice with respect to *b* it is easily shown that $b = \frac{1}{2} a$ (2), and by substitution from (1) that $C_{\text{H}} = k$. The perfect buffer solution should thus consist of two equivalents of a strong base together with one equivalent of a weak acid having a dissociation constant equal to the hydrogen-ion concentration required. This has long been known as an empirical relation, but we believe the above derivation to be original.

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Reactions of Organic Halides in Solution

IN a recent note[1], I discussed those reactions of organic halides in solution which involve substitution by a nucleophilic reagent at a saturated carbon atom. In reply to the letter by Profs. Hughes and Ingold[2] on this subject, I wish to make the following points.

In my note[1] I stated that the decrease in the bimolecular S_{N2} reaction-rate of the halide R–X as R varies along the series methyl, ethyl, *sec*.-propyl, *tert*.-butyl is attributed by Hughes and Ingold to the increase in electron accession to the reaction centre. In disagreeing with this statement, Profs. Hughes and Ingold say that they regard the polar and steric effects as both contributing to the structural influence on rate[2]. At the time of publication of my note, however, Hughes had estimated the steric compressions involved in the S_{N2} reactions of R–X for the methyl, ethyl, *n*-propyl, *iso*-butyl, *neo*pentyl series only. For the reaction of these halides with sodium ethoxide, Hughes had concluded (as mentioned in my communication[1]) that "The rate relationships for the first four members are fairly normal for the bimolecular mechanism, the rate of which is decreased by electron-accession to the reaction centre, but the introduction of the last β-methyl substituent has obviously introduced an effect which is far larger than that to be expected on the basis of its capacity for the release of electrons. . . . This effect is believed to be of steric origin."[3] This indicates that steric hindrance was considered to be unimportant in the bimolecular S_{N2} reactions of R–X when R is methyl and ethyl. The part played by steric hindrance in these reactions when R is *sec*.-propyl and *tert*.-butyl had not been specifically considered by Hughes and Ingold at this time. (Calculations of the steric compressions involved in the methyl to *tert*.-butyl series had been made, however, by A. G. Evans and M. Polanyi[4].)

With regard to the fact that an electron-attracting group often accelerates bimolecular nucleophilic substitutions in spite of steric hindrance, I did not state that the polar effect is "absent in general from bimolecular nucleophilic substitutions", I stated that there is strong evidence that the decrease in rate of the bimolecular substitution reactions of R–X with nucleophilic reagents for the series methyl, ethyl, *sec*.-propyl, *tert*.-butyl, and ethyl, *n*-propyl, *iso*-butyl, *neo*-pentyl, can be interpreted in terms of steric hindrance, but not in terms of electron accession to the reaction centre.

As regards the ambiguity of the polar effect in bimolecular reactions, I compared the behaviour of allyl chloride and its α- and γ-methyl derivatives, because I believe that this is an example in which ambiguity concerning the polar effect of the methyl group can be eliminated, and that the importance of the steric effect in bimolecular substitution reactions can thus be demonstrated for α-methyl groups and hence for the series methyl, ethyl, *sec*.-propyl, *tert*.-butyl.

Finally, the activation energy for the ionization of R–X is determined not only by (*a*) the ionization potential of R, but also by (*b*) the bond strength of R–X, and (*c*) the heat of solution of R^+. For the methyl, ethyl, *sec*.-propyl, *tert*.-butyl series, changes in factors (*b*) and (*c*) are approximately equal in magnitude and have opposite effects upon the activation energy of the ionization reaction. Thus, along this series it is the great decrease in factor (*a*), the ionization potential of R which is responsible for the marked increase in the rate of ionization (this point is discussed in detail in a forthcoming publication). For some other series, on the other hand, it may well be that the sequence of ionization rates is mainly determined by changes in factor (*b*), the bond strength of R–X, or in factor (*c*), the heat of solution of R^+.

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[1] Evans, A. G., *Nature*, **157**, 438 (1946).
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Survival of Oyster and Other Littoral Populations

THE problem of the maintenance of marine littoral populations and especially that of the European oyster (*O. edulis*) in Great Britain as discussed by Gross and Smyth in *Nature*[1] is one of great interest. In all species it is reasonable to assume that the properties of each particular organism give a measure of its attunement to the environment in its recent past, if not to the present. The supreme criterion and one hard fact of the sum of its relationships to life conditions is the number of young (larvæ) produced during the life of the individual. This provision of young has ensured survival of the species in the past against predators, parasites, competitors and normal and abnormal deviations in the total of chemico-physical conditions over the range of the environment. In a given locality, however, it is reasonable to infer that extinction may occur or tend to occur if the full span of life is not attained by the normal adult population. If therefore, the normal span of life is reduced in any locality, fewer young will be produced over that period of time which has ensured survival in the species as a whole, and a combination of local unfavourable conditions—or indeed any single one of a significant nature—will reduce the chance of survival and may result in local extinction.

As there is a tendency on oyster beds for all the larger oysters to be removed, it is fairly certain that the span of life in many localities has been reduced in the last few centuries; this factor must therefore be added to those given by Gross and Smyth as inimical to survival. The provision of a central spawning stock of large oysters has been advocated[2] and would be generally valuable in all producing areas.

Another important factor of biological significance is the great reduction in the number of holders of scattered small plots. An oyster bed is only assured of survival when the larvæ set free are returned in oscillations of the estuarine water[3] to that bed. Where there is only one part of a locality used as an oyster bed, the chance of larvæ returning to that particular spot has a low degree of probability; if there are twenty places in the same locality, the chance of larvæ returning to one or other of the twenty suitable places has a relatively high degree of probability, and survival in that locality is enhanced.

With regard to the suggestion of mass hybridization, this has virtually had a chance of operating in the Thames Estuary, where oysters have been imported by the oyster merchants themselves at one time or another from Brittany and other parts of France, Scheldte, Norway, Falmouth, Poole, Swansea and other parts of England and the west coast of Ireland. But the assumption that cross-fertilization occurs is not entirely warranted. "Fertilisation almost always occurs in the oviduct as Hoek deduced long ago (1883); but it is still a matter of conjecture to what extent cross-fertilisation occurs. Since females on English beds nearly always carry some sperm-morulæ amongst the eggs, self-fertilisation will nearly always be possible. On the other hand [functionally] pure males undoubtedly exist and spawn, and Hoek has described accumulations of sperm in diverticula of the renal duct of egg-bearing individuals. Thus sperm may be either collected from the individual itself [as a relict from the male phase] or from some other individual, so far as we know at present. Researches on this important aspect of oyster-culture are difficult and are [still] urgently needed. It is quite clear therefore that self-fertilisation may occur, whether cross-fertilisation occurs is not known, but is biologically probable."[4]

It should not be forgotten that *O. edulis*, like its near allies, is essentially an inhabitant of temperate regions, and it is significant that no temperate allied form occurs on the north-west shores of the United States of America—which come under the influence of the cold Labrador current—at latitudes similar to those of the prolific oyster-producing beds of France.

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A Revival of Natural Oyster Beds?

AT one time immensely rich natural oyster beds fringed many of the coasts of western Europe. Those of the French and Scottish coasts yielded tens of millions of oysters annually, but the banks along the English, Dutch, German and Danish coasts were by no means negligible. These oyster beds disappeared, no doubt through overfishing, and a few poor remnants, scattered along our coasts, economically of little or no importance, remind us of the once important fishery on the natural oyster beds. Only in France and Holland were new methods adopted in time, and an intensive oyster culture, spreading prosperity in the regions concerned, took the place of the old free fishery on the natural beds.

Recently, both British and German men of science[1,2] have tried to contrive a plan to restore the wealth of the natural oyster beds. Both recognize fully that overfishing was the cause of the decline, but they cannot understand why the natural oyster beds failed to recover after the termination of the fishery and even after re-laying reasonable quantities of French and Dutch oysters. Both ascribe recent failures of efforts to raise the population of remnants of natural oyster beds to inadequate properties of the mother-oysters used, and suggest the selection of certain strains of oysters or even mass-hybridization; and both hope that a general revival of the once prolific oyster beds will start from the moment that a limited stock of mother-oysters of the desired qualities occupies the banks.

I feel fairly sure, however, that both plans are doomed to failure, as in both the same mistake is made: the reproductive power of the oyster, *Ostrea edulis* L., has been over-rated. Repopulation of natural oyster banks is possible as soon as natural reproduction surpasses natural mortality. Mortality in oyster populations is far from negligible, and the possibilities for natural reproduction are generally highly over-rated. 500,000–1,000,000 larvæ in one incubating mother oyster is indeed an enormous and promising number. But my data[3] collected in the Oosterschelde show that about 10 per cent of the planktonic larvæ are destroyed by plankton-eating animals during each tidal cycle, and 4 per cent are swept away by currents to areas unfavourable for fixation in the course of one tidal cycle; the latter figure will certainly be much higher in estuaries less enclosed than the basin of the Oosterschelde. Water-temperature influences the rate of development of the larvæ, low temperatures slowing it up. In the Oosterschelde, about 5 per cent of the larvæ produced reach the 'mature' stage, ready for fixation, at 20° C.; about 2½ per cent at

18° C Though oyster farmers place millions of limed tiles and thousands of cubic metres of mussel-shells at the most favourable time in the water of the Oosterschelde, only about 1 per cent of the 'mature' larvæ succeeds in finding a collector and in accomplishing fixation, the other 99 per cent perishes Many of the newly settled spat perish in the first weeks of sedentary life, and in spite of all the care of the oyster-farmers, it is considered normal if 10 per cent of the spat survives until October, not to mention the losses by severe frost in the following winter, and those by shifting sand or silt or by predators and diseases before the age is reached at which they participate in reproduction. It may be concluded that the 'useful effect' is not very great in the propagation of *Ostrea edulis*, even when the oyster farmer intervenes, the most perilous period being that during which it is urgent to find a collector

How are 'mature' oyster larvæ to find any cultch on the natural oyster beds if it is not provided by the oyster farmer? Practically the only hard and clean objects available there are the new shell-edges of the growing oysters themselves[4] This is the reason why oysters are so often found in clusters on the natural beds instead of singly. When the beds had a rich population, many larvæ were produced and the oysters themselves provided the cultch in the form of their clean new shell-edges. Natural banks could thrive even on less-favourable spots thanks to the great number of oysters present in the community. Then man interfered He overfished the beds and the phenomenon described above contributed to a rapid decline, for large oysters were fished away, diminishing both the number of mother oysters and the quantity of natural cultch, and at the same time innumerable young oysters, attached to the shells of the larger ones, were destroyed This depletion process is accelerated as soon as oysters become so scarce on the natural banks that fertilization possibilities diminish and only part of the maternal eggs are in a position to produce larvæ That means the end of a natural oyster bed.

What can we do to stop the decline? When the population is poor, and no cultch is planted, spatfall prospects are negligible The provision of cultch is only profitable if enough spat is collected to pay the charges, and that will not be the case when too few larvæ reach the mature stage. In the favourable conditions of the Oosterschelde, we need at least 10,000,000 mother-oysters if enough spat is to be produced in an average summer. It will be clear from the foregoing why I do not believe the British and German plans to restore the natural oyster beds can be successful, as both want to start with a very limited number of mother-oysters and say nothing about the planting of cultch material.

Is there no hope for revival of once prosperous oyster beds? There is a possibility, but only if one is prepared to invest a lot of money in it, and to work on a large scale. In the first place a suitable area should be selected, ensuring a restricted dispersal of the larvæ and a suitable temperature for larval development. A wide area of bottom surface should be cleaned thoroughly with oyster dredges. Several millions of mother-oysters should be planted there, more according as hydrographical conditions are less ideal. I believe it is not very important from which country the mother-oysters come Cultch should be planted on a large scale and in due time, in deciding the right moment, scientific investigations can help a great deal.

It may be objected that my suggestions do not aim at a revival of natural oyster beds, but at the foundation of oyster culture. Indeed, that is true. Oyster culture may be possible in several suitable places on the coast of Europe, but natural oyster beds, once severely overfished, are doomed.

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Occurrence of Foot Louse of Sheep in the British Isles

WE wish to record the first known occurrence in the British Isles of *Linognathus pedalis* (Osborn), the foot louse of sheep. In June 1946 a heavy infestation of this parasite was reported by Mr. C. T. Murphy on the legs of a flock of a hundred cross-bred Suffolk sheep, near Colchester, Essex. The lice were identified in this laboratory as *L. pedalis*, and a part of the material has been placed in the collections at the British Museum (Natural History).

Linognathus pedalis is a sucking louse which previously had only been recorded from sheep in the United States, South America, New Zealand, Australia and South Africa. Heavy infestations of this louse cause considerable irritation and loss of condition of the host, and its introduction into Great Britain is to be regretted Control of this parasite, with modern insecticides, should not, however, be difficult.

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Control of Wireworm

Thomas and Jameson[1] state that as a result of the application of 'Gammexane' in field trials reductions in wireworm populations of up to 65 per cent have been obtained. Numerous similar trials were laid down by the Cambridge Advisory Centre in the spring of 1946, in conjunction with Imperial Chemical Industries, Ltd. 'Gammexane' was applied in powder form at various strengths, to test its efficiency in the control of wireworms on arable crops. In the majority of these trials, which included wheat, oats, barley, sugar beet and reseeded grassland, the plant establishment in treated plots was satisfactory or normal compared with plots receiving no treatment, where it was poor or failed entirely

Five centres where the crop differences were very striking, were selected for intensive sampling and investigation, to find if 'Gammexane' treatment caused any marked reductions in the wireworm population. Each centre consisted of five 'Gammexane' treatments and a control untreated in twelve replicated plots Twenty standard 4-in diameter cores were taken from each plot, in the growing crop in May and June, in all 240 samples per centre Each core was split in two, the top three inches being bulked separately from the bottom three inches This was to find if there was any downward migration of wireworms as a result of the treatment The samples were examined by the wet or flotation extraction method[2].

At four of the five centres examined, the populations were found to be similar to the initial populations, as first estimated before treatment Only at one centre was there an apparent reduction in population The results were examined statistically and only at one centre was the difference between treatments and controls significant. No downward migration of wireworms was demonstrated

As these findings did not offer any explanation of the striking crop differences obtained, a simple test was devised to discover if 'Gammexane' had any inactivating effect on the wireworms R. C. Amsden had previously demonstrated that wireworms could be extracted by placing soil in trays in a water bath, until the surface temperature of the soil reached 40° C. This treatment by heat causes large numbers of active wireworms to come to the surface, from which they can be picked off. Twenty cores were again taken from each plot at three of the above-mentioned centres, and treated by this method. The soil was afterwards examined by the wet method to recover the wireworms still remaining in the soil. At two of the centres a higher proportion of wireworms came to the surface in the samples from untreated plots than from treated plots. A statistical analysis of these results showed that the difference was highly significant The figures at the third centre, however, showed no difference between treated and untreated plots.

All centres are being sampled again on the completion of harvesting. The results so far show that the wireworm populations in the untreated plots are only slightly lower than the first estimation, whereas the populations in the treated plots are now considerably reduced, in some cases to the extent of 60–70 per cent.

These findings seem to suggest that the application of 'Gammexane' quickly renders the wireworm incapable of attacking the crop, but any killing action appears to be considerably delayed.

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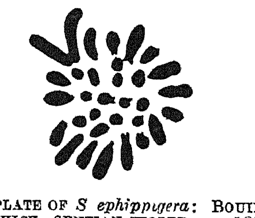
Polyploidy and Parthenogenesis in the Genus *Saga*

THE large wingless Tettigoniid grasshopper *Saga pedo* (*serrata*) is an inhabitant of southern Europe, its distribution ranging from Spain to the Ural Mountains. Among the northern outposts of its range are some localities in the Moravian mountains and Voronij, Saratov and Ufa in Russia. It is remarkable that this species, which occurs farther north than any other representative of the genus, appears to reproduce normally by parthenogenesis. The biology and cytology of *Saga pedo* was studied by Matthey[1] in material from the Swiss canton Valais. He found that the chromosome number of the parthenogenetic females generally amounted to 68, made up of six pairs of metacentric and twenty-eight pairs of acrocentric elements. This high number is unique among the Tettigoniidæ, the idiograms of which range from 22 to 36 in all other species investigated. Matthey suggested therefore, that *S. pedo* must in reality be a tetraploid.



SPERMATOGONIAL PLATE OF *S ephippigera*: BOUIN, SECTION 14 μ THICK, GENTIAN VIOLET. × 1850

Saga ephippigera and *Saga gracilipes* had originally been chosen as objects of a cytological study because they represent an instance of two species inhabiting the same area. They are sporadically distributed almost throughout Palestine, both species frequently occurring in closely neighbouring localities. *S ephippigera* is noteworthy for its giant size (total length of larger females including ovipositor, 125–135 mm.), which is nearly equalled by the largest specimens of *S gracilipes* (total length of larger females including ovipositor, 107–120 mm). Both species are bisexual. The examination of their idiograms has furnished a full confirmation of Matthey's assumption.

In a number of males of each of these species, the diploid chromosome number in the spermatogonia was found to be 31. There is a certain discrepancy between this number ($2n = 30 + X$) and that of the female *S. pedo* ($4n = 64 + 4X$). However, one male of *S. ephippigera* possessed a supernumerary pair of chromosomes, thus showing 33 elements in the spermatogonia, and sixteen tetrads and one dyad in all first spermatocytes throughout the testis. This exceptional number ($n = 16 + X$) makes a perfect fit with the tetraploid number of *S. pedo*. It seems plausible that the establishment of a supernumerary pair of chromosomes may have occurred in *S pedo* previous to the doubling of the chromosome number

As regards the structure of the chromosomes, both *S gracilipes* and *S. ephippigera* agree in having a J-shaped *X* and a graded series of acrocentric autosomes. (The arms of the *X* are nearly equal in *S ephippigera*, whereas the *X* of *S gracilipes* has markedly unequal arms) The four pairs of *V*-shaped elements present in *S pedo* in addition to the two pairs of *X*'s would appear to have evolved by intrachromosomal rearrangements in originally acrocentric chromosomes rather than by centric fusion[2].

It may be concluded that in the case of *Saga pedo*, as in the well-known instances of *Artemia*, *Trichoniscus* and *Solenobia*, polyploidy occurs in conjunction with parthenogenesis In *Saga*, as in the two latter genera, the parthenogenetic polyploid has a wider geographical distribution and reaches farther north than its diploid bisexual relatives.

It is of some interest that the largest tetraploid females of the Swiss race of *S pedo* which formed the material of Matthey's investigation were considerably smaller (99 mm total length including ovipositor) than good-sized females of either of the diploid species in Palestine.

Details of the cytology of the bisexual species will be published elsewhere.

Thanks are due to Dr. G. Haas, who kindly provided some of the cytological material and who participated in the earlier phases of this study.

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Diatoms Without Siliceous Frustules

DIATOM material freshly gathered during February 1946 from Chichester Harbour was identified as *Navicula ramosissima* (Agardh) Cleve The organism was arranged in files within a filamentous muco-gelatinous sheath forming frondose colonies up to 10 cm in length. When the filaments were placed in diluted sea-water, differences in osmotic pressure caused the diatom cells to be extruded from the envelope These cells were taken up with a sterilized pipette and allowed to fall upon the following nutrient agar medium (Medium 1): disodium phosphate 0·02 gm., sodium nitrate 0 10 gm, soil extract 50 c.c, agar 10 gm., sea-water 1,000 c.c. The colonies were at first very slow to develop, but after several days cell division proceeded fairly regularly for about a week, after which the colonies became quiescent and showed signs of failing.

Subcultures were made on another medium (Medium 2) containing disodium phosphate 0·1 gm, sodium nitrate 0·2 gm., soil extract 50 c.c., copper sulphate, trace, agar 10 gm, sea-water 1,000 c c Great activity was noted after 48 hours, and reproduction continued for several days. After a week, however, the cultures appeared to be waning, and examination under the microscope showed that the siliceous frustules were being burst open, and the cell contents extruded, enclosed within an intact perizonium, an extremely tenuous membrane which would often break by pressure from a cover-glass when preparing a mount.

Fresh sub-cultures of these naked protoplasmic bodies were made upon the second medium. The naked cells retained the characteristic healthy brown colour of the normal cells, but bore no trace of the markings characteristic of the species. The division of the chromatophores and other cytoplasmic elements appeared to be in every way normal, and division took place along the longitudinal axis in what would have been the valvar plane. The chromatophores consisted of two flattened bodies oblong-lanceolate in shape, often folded longitudinally, measuring approximately 22 μ long by 5 μ wide when first liberated. After being cultured for three months, the protoplasmic masses lost a good deal of their rectangularity, became globular and underwent a reduction in size. The cells, devoid of the rigid siliceous frustule, had now lost all normal powers of locomotion and spread themselves slowly over the surface of the agar, forming dense irregularly shaped colonies. After culturing for seven months on Medium 2 all the protoplasmic masses had adopted, more or less, the same globular shape and had a diameter of 8–10 μ, and exhibited a hyaline marginal area about 2 μ wide between the chromatophores and the perizonium.

Smears of the agar culture were prepared upon glass slides and placed in diatom-free static nutrient sea-water (in 100 c.c. beakers) and in a specially designed dripping apparatus through which the nutrient sea-water (Medium 1) flowed at a rate of about 10 litres in 24 hours. After ten days it was noticed that rich colonies of diatoms had grown over the slide and on the bottom of the beakers and throughout the dripping apparatus. Upon microscopic examination, it was found that the form of the protoplasmic bodies was returning to the naviculoid, although irregularities persisted. Quite a number had regained the power of movement and had formed chains of ten or twelve cells. The new or re-established cells varied from 13·5 to 17 μ in length and from 4 to 5 μ wide. Quantities of culture media kept as controls showed no diatom development.

Very little is known concerning the factors governing the secretion of silica by the diatom cell. Bachrach and Lefèvre[1,2] found that under some unknown cultural conditions certain small marine diatoms failed to produce siliceous frustules, and such forms showed no signs of decreased virility. A form of *Nitzschia closterium*, first isolated by Allan and Nelson[3], has been kept in culture for more than thirty years, and Wilson[4] describes triradiate and oval cells as well as normal ones, but there is no suggestion that the oval cell was produced by the liberation of the protoplasmic mass from the siliceous frustule. Geitler[5] observed the liberation of protoplasts from frustules of marine diatoms in culture and suggested that the phenomenon was pathological. It is difficult to suggest why the frustules of *Navicula ramosissima* ejected their protoplasmic masses, as it was not the result of a planned experiment. It seems that it was due to variation in the internal pressure of the cell brought about by the relative concentration of the culture medium It is unlikely that the failure to produce siliceous frustules while in agar culture was due to exhaustion of the natural silica content of the medium The re-establishment of the normal naviculoid shape is probably controlled by the flowing of the aqueous medium, for the most active and perfectly re-formed cells were found on the inside of the outlet tube from the dripping apparatus, that is where the rate of flow was greatest

Acknowledgment is made to Board of Admiralty for permission to publish the foregoing work, which forms part of a general investigation on the antifouling problem relating to ships, in progress in this Laboratory

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Protein of Fruits

IN continuation of the work on apple-fruit protein, it has been found that if, after the initial treatment of the frozen and ground tissue with alkaline buffers[1], extraction with this buffer is prolonged for several hours at 1° C and the tissue is then washed with a small quantity of the buffer, the combined extract and washings may contain as much as 85 per cent of the original protein. A much larger proportion of non-nitrogenous material is also dispersed into the solution, with the result that when precipitation of the protein-complex is caused by adjustment of the pH to 6, the nitrogen content of the precipitate is only 5 per cent. At pH less than 4 or, if precipitation is brought about by treatment with ammonium sulphate (to half-saturation), the nitrogen content falls as low as 4 per cent. Of great interest is the fact that the ammonium sulphate precipitates are partially soluble in water or phosphate buffer of pH 8, and the resultant solutions, after dialysis at 1° C., show a positive oxidase action, a strong peroxidase action and a small but definite amylase action (greatly reduced, no doubt, by the presence of tannin). Acid precipitates, however, even after precipitation at low temperatures, are practically insoluble in water and exhibit none of the above enzyme activity.

The nitrogen content of the ammonium sulphate precipitates cannot be raised above 5 per cent by repeated reprecipitations, and the enzyme activity is much reduced during this process, even when care is taken to keep the temperature as low as possible.

A fairly stable complex appears to be involved, and new methods are being tried to split this complex and liberate for study the enzymes it undoubtedly contains.

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Glycogen Phosphorylysis in Alloxan-diabetic Rats

IN a previous communication[1] we reported that the rate of glucose resorption from the small intestine of alloxan-diabetic animals is increased with the degree of diabetes, and that administration of insulin brings this rate down again to its normal value. Starting from the now proved fact that the rate of glucose resorption is dependent on the rate of phosphorylation, we examined whether alloxan-diabetic rats show an increase of the rate of phosphorylation. We found that the rate of glycogen phosphorylysis in muscles of alloxan-diabetic rats was increased by 63 per cent after 15 minutes and by 69 per cent after 30 minutes incubation time. By adding insulin *in vitro*, the rate of glycogen phosphorylation is diminished. We were able to confirm the results of Schumann[2] and those of Verzár and Montigel[3] that glycogen phosphorylysis in muscle of adrenalectomized rats is lowered

On measuring the fractions of phosphoric acid in blood by Lohmann's[4] method of hydrolysis, we found an increase of 55 per cent of pyrophosphate, of 58 per cent of hexose phosphoric acid and of 33 per cent of the amount of total acid soluble phosphorus, as shown in the accompanying table.

FRACTIONS OF PHOSPHORIC ACID IN BLOOD (MGM PER CENT AVERAGE)

	Inorg. P	7-min. hydrolysis	180-min. hydrolysis	Total acid-soluble P
Normal	3 81	1·81	2 57	25·1
Diabetic	4·29	2 81	4 05	33·0

Determinations of phosphatase in blood plasma gave the following average results: 26 units in normal animals; 43 4 units in alloxan-diabetic animals; and 14 units in adrenalectomized ones.

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Alloxan Diabetes and Kidney Function

It is a well-known fact that the intravenous injection of high diabetogenic doses of alloxan (80–100 mgm per kgm) in the dog produces a very severe diabetic-uræmic syndrome With such doses the death of the animals follows as a rule within one week, the cause of the death being probably due to the disturbance of the renal function[1,2,3] In the course of our experiments on alloxan diabetes in the dog, we have been faced with this fact, which prevented us from keeping the animals with severe diabetes for further study. It was thought that clamping of the renal vessels previous to the alloxan injection, maintained a few minutes after the end of the injection, would avoid the kidney damage, since we have been able to demonstrate the rapid inactivation of the alloxan in contact with the blood and body tissues[4]. Our former experience shows, in fact that after ten minutes of contact with blood at 37° C *in vitro* a diabetogenic dose of 100 mgm. alloxan per kgm. does not evoke its diabetogenic effect

In order to test our theory the following experiments were performed a group of five normal dogs were injected with alloxan during clamping of the renal vessels Two of the dogs received 80 mgm of the drug per kgm., and the other three 100 mgm. per kgm. Just before the alloxan injection in the saphenous vein, the abdomen was opened under local anæsthesia (with procaine solution, without adrenaline), and the usual aseptic care. After dissection of the renal pedicles, one clamp was placed in each side suppressing the blood flow in both kidneys The alloxan was then injected, and the clamps removed ten minutes after the end of the injection The abdomen was closed with suture, and the animal, which behaves as a normal one, is replaced in the cage. Venous blood samples are taken for glucose and urea estimations, just before the injection of alloxan, and afterwards every hour for eight or ten hours, and on the following days

Other five dogs have been treated in the same way (including procaine, opening of the abdomen, suture, etc.) but no clamps were placed on the kidney vessels

Table 1. Effect of intravenous injection of alloxan in the dog

(*a*) Dogs with clamped kidney vessels.

Dog number	Alloxan mgm / kgm	Blood sugar (mgm. per 100 c c) Before alloxan	After alloxan (hours) 1	2	3	4	5	6	7	8	24	48
248	90	80	—	73	67	40	23	23	20	23	117	117
249	90	87	90	127	103	87	70	50	47	27	77	60
250	100	80	90	153	132	80	43	50	43	50	153	103
251	100	97	173	160	137	100	177	33	27	37	130	103
252	100	93	170	163	107	93	87	80	60	50	93	88

(*b*) Dogs with non-clamped kidney vessels

Dog number	Alloxan mgm / kgm	Before alloxan	1	2	3	4	5	6	7	8	24	48
240	80	77	143	177	197	207	143	83	43	33	320	1060
253	100	73	170	167	143	110	77	37	70	27	70	1000
254	100	90	140	—	—	—	—	—	—	—	237	347
262	100	77	147	200	—	—	—	—	—	—	280	—
263	100	87	163	190	—	—	—	—	—	—	197	657

Table 2. Blood urea in dogs after alloxan injection. Dogs from Table 1 Urea in mgm. per 100 c c

Clamped kidney vessels Dog number	Before alloxan	Hours after alloxan 24	48	Unclamped kidney vessels Dog number	Before alloxan	Hours after alloxan 24	48
248	42	80	42	240	56	480	688
249	32	32	52	253	28	112	360
250	52	64	66	284	—	240	544
251	40	38	60	262	40	152	—
252	36	44	62	263	40	140	512

As seen in Table 1, both groups of dogs show the known glycæmic response to the alloxan, but, surprisingly, the dogs with clamped kidney vessels do not have hyperglycæmia forty-eight hours after the injection. These dogs are neither diabetic nor uræmic, and in contrast with the non-clamped ones they live without hyperglycæmia, glycosuria or elevation of blood urea, and with a normal aspect, two months after the administration of alloxan. The unclamped dogs died between two and seven days after the injection with hyperglycæmia and very high uræmia (Table 2).

It seems, therefore, that avoiding the contact between the kidneys and the blood carrying alloxan, during the time necessary for the inactivation of the drug, not only prevents the kidney damage and the uræmia, but also the diabetic disturbance. These results indicate that the kidney plays some hitherto unknown part in the development of alloxan diabetes; the contact between alloxan and the kidney is apparently necessary for the display of the full diabetogenic effect.

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An 'Incomplete' Form of α Agglutinin

In the *Rh* system of blood groups two forms of antibody have been described, an agglutinin and an 'incomplete', 'blocking' or 'conglutinating' antibody[1,2] The iso-agglutinin can be detected by the ordinary iso-agglutinin technique[3], which, however, fails to detect the incomplete antibody The presence of the latter in a serum can, however, be demonstrated by the blocking test[1], the Coombs test[4], the Diamond slide test[5], the conglutination test[6], and the albumen test[7]

Attempts to demonstrate an incomplete antibody in the *ABO* system have heretofore proved unsuccessful However, the fact that with certain anti-*A* sera better agglutination with group A_1 red cells was obtained at a dilution of 1 16 or 1 32 than with undiluted serum[8] seemed to us to indicate the possible presence of an 'incomplete' or 'blocking' antibody. Two such sera, therefore, were chosen and tested

These were very potent immune anti-*A* sera from persons of group *O* (Taylor–Sparks) produced as a result of injection with *A* group specific substance isolated from pseudomucinous cyst[9] It was thus first necessary to inactivate the iso-agglutinin, which was readily detectable at all dilutions up to a titre of 16,000 and 8 000 respectively. It has been shown[10] that while the anti-*Rh* agglutinin is rendered inactive by heating at 70° C. for 5–10 minutes, the incomplete antibody is still active However, as the anti-*A* agglutinin seems to be more heat-stable than the anti-*Rh*, the sera containing immune anti-*A* agglutinins were heated for 20 minutes at approximately 75° C , after which they were tested against A_1 cells at room temperature and were found to give no agglutination With A_2 cells there was slight agglutination ((+)), with *B* cells the agglutination was slightly stronger.

The heated sera were then tested for the possible presence of an incomplete form of anti-*A* antibody by the blocking test[1]. One volume of serum and one volume of a 2 per cent suspension of A_1 red cells were mixed in a small tube and allowed to stand at room temperature for one hour The supernatant fluid was then withdrawn from the tube and a unit volume of a strongly agglutinating anti-*A* grouping serum (titre 512) was added A control tube, containing the same A_1 red cells, which, however, had not been exposed to the test sera (Taylor–Sparks), and a volume of the anti-*A* grouping serum, was included in the experiment After two hours at room temperature, the A_1 red cells which had first been treated with the heated test sera (Taylor and Sparks) gave no agglutination with the anti-*A* serum, whereas in the control tube the red cells were completely agglutinated This experiment clearly demonstrated that the expected agglutination between the *A* cells and the anti-*A* serum had been blocked by a factor contained in the sera (Taylor and Sparks), whereas the red cells which were not first exposed to the Taylor and Sparks sera were agglutinated normally To show that the blocking was specific for the *A* cells, blocking tests were also carried out using group *B* cells In these there was no blocking of the anti-*B* agglutination.

It was next decided to attempt to demonstrate the presence of the blocking antibody in the sera (Taylor and Sparks) by the Coombs test One volume of each of the heated sera was mixed with a 2 per cent suspension of A_1 red cells and allowed to stand for 1 hour at room temperature as for the blocking test The A_1 red cells were then carefully washed and an anti-human serum rabbit serum added to them Almost immediately the cells were strongly clumped, showing that they had become sensitized by an antibody. Group *O* cells subjected to the same treatment were not clumped

The blocking or incomplete antibody in Taylor and Sparks heated sera was also demonstrated well by the Diamond slide test, and rather less conclusively by the Diamond albumen test.

It may be significant that in both the instances the incomplete *A* antibody was found in an immune serum (it is possible that it does not occur naturally and is only produced as a result of stimulation by the homologous antigen) We are planning further work to elucidate this point, but our experiments to date have shown that incomplete *A* antibodies occur and furthermore, that a positive Coombs reaction can be obtained in the *ABO* system

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Enhancement of Immune Antibodies by Human Serum

It has been observed that the use of human serum, instead of saline, as a diluent in titration of immune agglutinins (*A*, *B*, *Rh*) enhances the action of these antibodies, and higher titres are therefore obtained[1] Similarly, the 'conglutination-test' for the detection of *Rh* sensitization is also based on the use of human serum, instead of saline, for dilution in titration[2]. In describing the 'conglutination-reaction', Wiener suggested that this is due to a serum factor, a protein, which is not fully developed in the fœtus and is formed only shortly after delivery[2,3]. The post-natal formation of sufficient quantities of this protein would presumably account for the development of erythroblastosis fœtalis after delivery, and not during pregnancy.

We have tried to determine whether the property of serum to enhance the action of immune antibodies is present in sera of newborns or infants up to eighteen months of age The sera studied were taken from umbilical blood, infants up to the age of eighteen months, and adults in the pregnant and non-pregnant state, as controls These sera were used as diluents for titration of two immune anti-*Rh* sera (titres 1 256, 1 64), and anti-*A* serum (titre 1 : 256,000) and an anti-*B* serum (titre 1 2,048).

The results of titration with these various sera are tabulated below. A serum was considered to be 'enhancing' when in titration it reacted like mature serum By the term non-enhancing' sera, we refer to sera which reacted in a manner similar to saline as diluent.

Age	Number of sera examined	Number of 'non-enhancing' sera	Number of 'enhancing' sera
Umbilical blood	40	37	3
1–6 months	11	11	
6–18 months	4		4
17–40 years	13		13
Pregnant women	12		12

In one case the serum of a child aged three months gave higher titres than those obtained with saline as diluent, but much lower than the titre obtained with mature serum In the beginning of this study, three sera from umbilical blood gave titres similar to those of mature sera

The results reported above indicate that human serum at birth and during the first six months of life lacks that serum factor which confers upon it the ability to enhance the action of immune antibodies Unless the human placenta, in certain conditions, is permeable to this serum factor from the mother's blood, it does not seem likely that the development of erythroblastosis fœtalis after delivery is due to the neo-natal formation of this serum factor

Our findings confirm the observations made by Boorman, Dodd and Morgan[1] insofar as the ability of *mature* sera to enhance the action of immune antibodies is concerned The identical enhancement of human sera in respect of immune anti-*Rh*, as well as anti-*A* and anti-*B*, would seem to be in disagreement with the view that the 'conglutination-test' is due to a special antibody (glutinin)[2,3].

A detailed account of the work reported here will be published elsewhere

We are indebted to Prof B. Zondek for his interest and to our colleagues of the Pediatric Department for their kind supply of blood specimens

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The Thyroid and Tuberculosis

BARRY'S recent communication[1] on the resemblance of the chemical constitution of thyroxine to that of diploicin which was isolated by Nolan[2] from the lichen *Buella canescens*, and which, according to Burger and associates[3], possesses tuberculostatic activity *in vitro*, has induced us to give the following summary concerning the influence exerted by thyroxine and hypothyroidism on the course of experimental tuberculosis in the guinea pig.

Thyroidectomized guinea pigs are more susceptible to tuberculous infection than are the controls, while those injected with 30 micrograms of thyroxine, twice a week, are more resistant against tuberculosis.

In the course of the same month in which tuberculous inoculation took place, deaths occurred in 30 per cent thyroidectomized, 5 per cent controls, and in none of those which had received thyroxine injections. During the third month, mortality was as high as 75 per cent in thyroidless animals, 60 per cent in the controls, and only 15 per cent of the hyperthyroid animals. During the seventh month, the only survivors were 15 per cent of the animals treated with thyroxine, while all thyroidectomized and control animals had succumbed

Resistance against tuberculous infection was greater in the animals in which thyroxine treatment had been instituted one month before their inoculation with bacilli

The thyroidectomized animals were given calcium and parathyroid hormone in order to prevent the disturbances due to thyroid deficiency.

Pathological anatomical studies of the organs revealed lesions the characteristics of which depended on the time of survival. The animals with longer survival periods had developed caseous lesions to a larger extent than had those which had died early, the lesions being of a congestive type.

The greater resistance toward tuberculous infection of the animals injected with thyroxine appears to be due either to tuberculostatic activity, or to greater immunity, for example, increase of alexines as observed by Fassin[4], of opsonic index and of micro- and macro-phagocitary activities as demonstrated by Marbé[5] and Asher[6].

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Uranium in Urine

DURING some work in this Research Department on compounds of uranium, as a safety precaution, we commenced to analyse the urine of personnel concerned, using a fluorimetric method In the preparation of fluorimetric standards, known amounts of uranyl nitrate were added to samples of urine from persons not engaged on the work with uranium To our surprise we found uranium to be present in some of the 'blank' urine samples It was found that analysts who had recently been engaged in the determination of sodium as sodium uranyl magnesium acetate[1] voided traces of uranium in their urine, the element being detected for some weeks after the analyst ceased to be using 'sodium reagent' Out of 14 analysts examined between January 28, 1944 and February 1, 1944, six (Nos 1–6 below) who had been in contact with magnesium uranyl acetate solution during the past two months had urine containing 2–10 μgm per litre of uranium, eight (Nos 7–14) who had not been in such recent contact with uranium salts varied from 'not detected' to 4 μgm per litre. The table gives the experimental figures, expressed as μgm uranium per litre.

Analyst	January 28	January 29	January 31	February 1
1			4	10
2		10	4	4
3	6			6
4	6			6
5			10	6
6			10	6
7	<2			
8	2			
9			2	4
10			2	
11			2	4
12			2	
13		2		
14	<2			

The fluorescence was compared visually, against standards equivalent to 2 6 or 10 μgm per litre, 2 μgm. per litre being the limit of detection by the method used

Careful examination by the works medical officer failed to detect any deviation from normal health in analysts 1–6, but we think it should be made known how readily this element may be absorbed. In the case under discussion, the reagents used by the analysts were an aqueous solution containing 43 gm. uranyl acetate per litre in addition to magnesium acetate and acetic acid and also an alcoholic solution, made by saturating alcohol with (almost insoluble) sodium magnesium uranyl acetate We are inclined to think that it may be the second of these solutions which is more likely to penetrate the skin.

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[1] Cf. Caley, E. R., and Foulk, C. W., *J. Amer. Chem. Soc*, **51**, 1664 (1929).

"Conditions of Survival"

IN common, I imagine, with many readers of *Nature*, I was extremely disturbed by the editorials of September 28 and October 5 on "Conditions of Survival". We have long been accustomed to have in these editorials of *Nature*, sober and constructive examination of the social implications of science It is all the more surprising to find ill-considered intrusions into political topics, the effect of which—whatever the intention—is to increase the divisions in a world where unity is the essential condition for survival.

I do not wish to dwell on the main topics—the control of atomic energy and U.N.R.R A —because events in the intervening period have already falsified the worst fears that were raised in the editorial. Since it was written, the Scientific Committee of the Atomic Energy Commission—of which the Soviet Union is a member—has issued a unanimous report declaring that the control of atomic energy is possible. The question at issue now is not the refusal by the Soviet Union to surrender national sovereignty but that of the United States to accept the prohibition of the atomic bomb and its insistence on attaching to the Lilienthal report the political condition of the abolition of the veto. As Prof. Blackett has ably pointed out[1] the veto is the only guarantee that a security organisation can function without producing the war which it is its object to prevent.

At the same time, in other spheres, the picture is far from being as black as it was painted. There are increasing signs of greater international co-operation as witnessed by the Stalin interview, the proceedings at the Peace Conference and the setting up at Copenhagen of the World Food Board under the presidency of Sir John Orr.

In this atmosphere it is all the more regrettable that *Nature* editorials should contain statements which are not only unfounded but highly injurious to the cause of peace The editorial of September 28 states that "in deference to the U.S.S R., Great Britain and America have abandoned the principles involved in the Atlantic Charter". Now in the first place the principles have not been abandoned : the difficulties in realizing them in practice are being slowly but surely overcome. These difficulties can no more be attributed to the U.S.S.R. than to the other allies · they are inherent in the situation at the end of the War. Wide divergencies of policy about the best means of effectively preventing the resurgence of fascism and of aiding the reconstruction of the devastated countries are bound to exist and will need the utmost good will and good faith to overcome.

These divergencies, however, are quite distinct from the moral antagonism stressed throughout both editorials. It is not a fact that "the aims and values of Soviet Russia are not those of Western

Europe". The very form of this statement shows how far many well-intentioned people have fallen into the trap prepared for them by Dr. Goebbels The concept of a Christian Western Europe containing all the virtues as a bulwark against the evils of bolshevism was one of his favourite ways of justifying Nazi Germany and is being echoed even to-day by his tolerated disciple General Franco. To fall for this 'holier than thou' attitude is a particular weakness of Anglo-American culture it is apt to appear to other countries as nauseating hypocrisy. Men of science in Great Britain should be more wary of accepting this flattering ascription to themselves of the monopoly of moral values Quite apart from the fact that the Soviet Union has as good a claim as a Christian country and as heir to the same classical culture as ourselves, the cultures of Islam, India and China have contributed their share to the common heritage "Respect for human personality, freedom of worship freedom of investigation" are far from being an exclusive mark of Christian ethics they are concessions won from Christian churches in a long struggle in which science played a notable part. Communism has never denied these principles; in fact the Soviet Union has asserted and upheld them fighting with us against those who openly rejected them In so far as we admit and propagate this concept of a radical moral division of the world, we increase the tensions that may ultimately lead to war.

The opportunity for new international unity which we all earnestly desire is to be found rather in the discovery of common grounds between ourselves and the Soviet Union than in pointing out superficial, and often fictitious, differences The resolutions of the International Council of Scientific Unions do effectively speak for science, and the Soviet Union is represented on many of these councils The same appeal for understanding and unity has in recent days been made by Henry Wallace and General Eisenhower We, as men of science no less than citizens, should know that it is in this direction that our contribution to world welfare can be made

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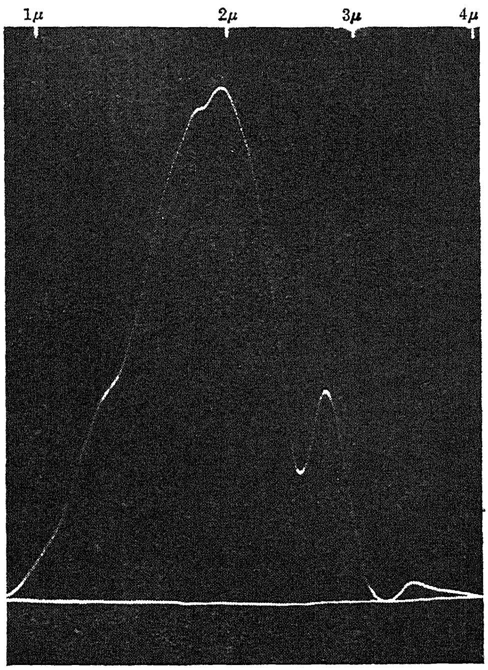
Oct. 7

[1] "The Atom and the Charter", published jointly by the Fabian Society and the Association of Scientific Workers (Sept 1946).

Infra-Red Recording with the Cathode Ray Oscilloscope

IN *Nature* of August 10, p. 196, King, Temple and Thompson have described under the above title an infra-red spectrometer in which the spectrum is displayed on a cathode ray oscilloscope. This spectrometer is virtually identical with the one which we described in *Nature* earlier this year (April 27, p. 547), except that the trace is smoothed after rectification The impression conveyed by their communication is that theirs was a parallel piece of work, which was concluded shortly after ours and was done quite independently No mention is made of the fact that our spectrometer was demonstrated to Dr. Thompson on February 28, when full details were given of our procedure, and that it was only after this information had been given that work was started at Oxford on this project. Furthermore, the modification mentioned, and claimed as an advance, was introduced by us some three months ago, and Dr Thompson was informed of this several weeks before the date of his communication to *Nature*

Once an advance of the kind we described has been made, it is obvious that many modifications and improvements can be made in the method of presentation. The accompanying photograph shows that the modifications which we have introduced since the date of our original communication make our apparatus considerably superior to the Oxford one in suppression of noise, indication of base line and detection of weak absorption bands Our spectrum is strictly comparable with that shown in Fig 2 of the communication from the Oxford workers.



INFRA-RED EMISSION SPECTRUM FROM A NERNST FILAMENT BETWEEN 1μ AND 4μ, SHOWING SUPERIMPOSED ABSORPTION BANDS AT 1·4μ, 1 9μ, 2 8μ (DUE TO H_2O AND CO_2 IN THE ATMOSPHERE), AND 3 3μ (DUE TO A THIN FILM OF HYDROCARBON MATERIAL)

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MY colleagues and I are not conscious of any act of impropriety in this matter, but the comments above give a misrepresentation of the position, to which I must reply briefly. It was shown more than two years ago by the work of Baker and Robb that a cathode ray tube could be used to record an infra-red spectrum, and the spectroscopic panel of the Hydrocarbon Research Group of the Institute of Petroleum decided to explore the problem as one of its several projects By mutual agreement between Dr. Sutherland and myself, this particular project was begun by him at Cambridge, since at that time duplication of the necessary apparatus would have been difficult, if not impossible. In company with others, several of my colleagues and I saw the instrument of Daly and Sutherland in operation on February 28, but received no information about its construction other than that contained in their communication in *Nature*, to which acknowledgment was made in our own communication. At that time, my colleagues raised with the Cambridge workers the possibility of using a smoothed trace, since we were hoping to use this method when the necessary bolometer could be obtained; but we were given to understand that Daly and Sutherland preferred their own form of record After obtaining a Bell Telephone thermistor in May last, we were able to complete our instrument and to demonstrate it to many visitors during June. I was eventually informed indirectly, and later directly by Dr. Sutherland, that he had now gone over to the form of recording which we had used. At no time yet have my colleagues and I ever seen any of the technical drawings or circuits used by the Cambridge workers, or had any details of the experimental arrangements not mentioned in their published note. So far as we can tell, our form of chopped wave, the amplifiers, and other electrical equipment, differ in some important features from those used by them, and the whole instrument differs from theirs much as two different types of spectrometer differ. As stated in our note, we also have already made, or are in process of making, several marked improvements since the original photographs shown in our note were taken

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WE note that Dr. Thompson and his colleagues do not consider there is anything improper in failing to acknowledge information given to them considerably before the date of publication.

Dr. Thompson's statement that no information (other than that contained in our original communication) was obtained by seeing our apparatus in action, and incidentally having every question answered on that occasion, is not justifiable. To take only one instance: the method of scanning by means of a carefully designed cam, coupled by potentiometer to the X plates of the cathode ray tube, and described by the Oxford workers in their note, but not in ours, was of course seen by them and explained to them and others present on that occasion. In this connexion, moreover, the third last sentence of Dr. Thompson's note makes puzzling reading

The implication in Dr. Thompson's note that we followed the Oxford group in introducing smoothing is also incorrect. We have never been informed what the Oxford workers were doing, and on two occasions when we visited Oxford, while their apparatus was under construction, we were not invited to see it. It is certainly true that we gave them no circuit diagrams, and this may well account for their obvious lack of success in eliminating 'noise' from their spectra.

Dr. Thompson refers to the work of Baker and Robb. This was indeed the first attempt to present an infra-red spectrum on a cathode ray screen, and we gladly acknowledge the stimulus which their work provided to us in this direction. However, the Baker and Robb apparatus was never completed, as they themselves state in their paper. Our attack on the problem differed fundamentally from that of Baker and Robb, and for the first time gave a simple practicable instrument which could be easily duplicated by anyone interested.

The statement that "the spectroscopic panel of the Hydrocarbon Research Group of the Institute of Petroleum decided to explore the problem . . . and by mutual agreement this project was begun at Cambridge" is misleading Dr. Thompson and one of us (G.B B.M.S.) were asked to submit *independently* to the Panel our proposals for future research. The problem of cathode ray presentation never appeared in Dr. Thompson's programme at any time, so there was no question of allocating it to Cambridge in any division of work; the really essential piece of this apparatus, namely, the thermistor bolometer, would have been just as accessible to Dr. Thompson as it was to us.

So far as we are concerned, we do not wish your columns to be burdened by any further communications on this affair.

E. F. DALY
G. B. B M. SUTHERLAND

MY colleagues and I feel that to deal with points made by Daly and Sutherland would only lead to fruitless correspondence; therefore, while repudiating the new charges brought against us, we will refrain from further comment.

H. W. THOMPSON

BOND-ENERGIES AND ISOMERIZATION

DURING the past three years, the Universities of Manchester and Leeds have held a number of meetings to discuss subjects of joint interest to industrial and academic research workers. These meetings—which began on a small scale—have gradually increased in popularity and scope, as instanced by the attendance of some hundred and seventy chemists from industry and the universities at the conference on "Friedel–Crafts Catalysts and Polymerisation" held in the University of Manchester in September last year[1], and more recently by an attendance of two hundred at a conference on "Bond-Energies and Isomerisation" held in the Chemistry Department of the University of Manchester on August 31. In welcoming the guests to this conference, Prof. M. Polanyi expressed his appreciation of the enthusiastic response made by industrial firms in these experiments designed to attain a closer co-operation between the universities and industry in problems of wide general interest to both.

The first paper in the morning session on the "Calorimetry of Carbon Bonds" was read by Dr. H. A. Skinner. The speaker discussed the value of modern calorimetric methods (as developed by Rossini and Kistiakowsky in the United States) in providing entirely reliable heats of reaction. Heats of formation, accurate to within 0·1 kcal. mole^{-1}, have been measured for the first five or six members of the homologous series of n-paraffins, mono-olefines, and monohydric alcohols. The data prove that there are small, but unquestionably real, variations in the C—C and C—H bond-energies as we pass from one compound to another. Direct evidence of a difference in the C—H bond-breaking energies in CH_4 and C_2H_6 was obtained recently by Stevenson and Hipple from electron impact studies, and independently by Kistiakowsky from kinetic studies of rates of bromination: the mean values from these investigations yield

$$CH_4 \rightarrow CH_3 + H - 102 \text{ kcal.}$$
$$C_2H_6 \rightarrow C_2H_5 + H - 97{\cdot}5 \text{ kcal.}$$

If accurate measurements of the heats of formation of compounds of the general class CH_3X, C_2H_5X (where X is a univalent atom or radical) can be made, the energy of disruption of the C—X bonds can be deduced from the equations:

$$Q_a(CH_3X) - Q_a(CH_3) = E(C\text{—}X) \text{ in } CH_3X$$
$$Q_a(C_2H_5X) - Q_a(C_2H_5) = E(C\text{—}X) \text{ in } C_2H_5X,$$

where the Q_a values are the heats of formation *from atoms*. The values of $Q_a(CH_3)$ and $Q_a(C_2H_5)$ are given by:

$$Q_a(CH_3) = Q_a(CH_4) - 102 = (124{\cdot}1 + L) \text{ kcal.}$$
$$Q_a(C_2H_5) = Q_a(C_2H_6) - 97{\cdot}5 = (235 + 2L) \text{ kcal.}$$

L is the heat of sublimation of carbon: but since it appears also in the quantities $Q_a(CH_3X)$ or $Q_a(C_2H_5X)$, the L terms cancel out in deriving $E(C\text{—}X)$. Values of $E(C\text{—}X)$ so obtained are therefore independent of any assumptions regarding the value of L.

Applying these equations to some specific examples for which reliable heats of formation are known, one can derive:

(i) $E(C\text{—}C) = 84{\cdot}3$ kcal., for the C—C bond in CH_3CH_3;

(ii) $E(C\text{—}C) = 80{\cdot}2$ kcal., for the C—C bond in $CH_3CH_2\text{—}CH_2CH_3$;

(iii) $E(C\text{—}O) = 90{\cdot}2$ kcal., for the C—O bond in $CH_3\text{—}OH$;

(iv) $E(C\text{—}O) = 91{\cdot}5$ kcal., for the C—O bond in $CH_3CH_2\text{—}OH$.

The fall in $E(C\text{—}C)$ from ethane to butane has been attributed to the radical resonance energy in the —C_2H_5 radical: the absence of a similar fall in the C—O bond-breaking energy passing from methyl to ethyl alcohol can be satisfactorily explained in terms of the increased ionicity of the C—O bond in ethyl alcohol relative to C—O in methyl alcohol.

The existing heat of combustion data on the methyl and ethyl halides are insufficiently accurate to allow reliable estimates to be made from the thermochemical data of the carbon-halogen bond-breaking energies. Studies by both kinetic and thermochemical methods are proceeding at Manchester to derive these latter quantities with some precision.

The determination of bond-energies from kinetic studies of simple decomposition reactions was the subject in the second paper, on the "Determination of Bond-Energies by Pyrolysis", given by Dr. C. Horrex (University of Sheffield). Dr. Horrex described the attempts which have been made to derive bond-energies by measuring the temperature variation in the equilibrium constants of decompositions of the type $AB \rightarrow A + B$. The method has been successfully used in a number of cases (for example, $I_2 \rightleftharpoons 2I$, $C_2N_2 \rightleftharpoons 2CN$, $OH \rightleftharpoons O + H$, $C_2Ph_6 \rightleftharpoons 2CPh_3$), but has limitations and is a difficult technique to apply.

The pyrolysis method was introduced by Rice and Johnson in 1934, who measured the temperature coefficients of the rates of decomposition of several organic compounds, and calculated the corresponding activation energies. The compounds were passed rapidly at low pressures through a tube heated to different measured temperatures, and the extent of decomposition into free radicals was determined by the Paneth effect on metallic mirrors. The measured activation energy can be identified with the bond-breaking energy of the primary process $RX \rightarrow R + X$, if secondary reactions between the radicals and the undecomposed RX do not occur, or can be prevented. Butler and Polanyi employed the pyrolysis method for study of the decomposition of organic iodides, $RI \rightarrow R + I$, measuring the rate of reaction by the amount of iodine formed. These investigators found marked variations in the C—I bond-energy as the radical R is changed. There is a steady drop in bond-energy in passing from MeI, EtI, nPrI, to *iso*PrI and *t*.-BuI. The technique used by Butler and Polanyi was not entirely satisfactory, and reproducible results could not be guaranteed. The activation-energies were calculated by assuming a temperature-independent factor of 10^{13}, and not from the temperature coefficients of the rates of decomposition.

The study of the pyrolysis of the organic iodides using a modified and much improved technique has now been started by Dr. Horrex and Dr. Szwarc. The results are very reproducible, and the activation-energies derived from the slopes of the graphs ln k against $1/T$ are independent of contact times and changes in the carrier gas. Experiments using EtI and $C_6H_5.CH_2I$ have been extensively studied, and yield the following results:

EtI: Activation-energy = 54 ± 1 kcal.
Temp.-independent factor = 12×10^{13}.

$C_6H_5.CH_2I$: Activation-energy = $29{\cdot}5 \pm 1$ kcal.
Temp.-independent factor = 10^9–10^{10}.

The result using ethyl iodide agrees with the earlier determination by Butler and Polanyi, but the earlier estimation of the benzyl iodide bond-energy placed it at too high a figure. The lower value ($29\frac{1}{2}$ kcal.) is in much better agreement with the value to be expected from the study of the reaction of benzyl chloride and sodium vapour, and points to a high resonance energy and marked stability in the benzyl free radical.

Dr. J. G. M. Bremner (I.C.I. (Billingham)) delivered a paper (prepared jointly with Mr. G. D. Thomas) on "The Extension of Thermodynamic Values from the Aliphatic to the Aromatic Series". The speaker showed that the free energy of formation of the aliphatic hydrocarbons can be expressed as a sum of contributions from individual groups, in somewhat similar manner to that in which the heats of formation can be expressed with reasonable accuracy as a sum of individual bond-energies. The free-energy values (over a range of temperature) for the groups CH_3, $>CH_2$, $>CH$, and $-\overset{|}{\underset{|}{C}}-$ have been tabulated, and when added together give results for the normal paraffins agreeing closely with Rossini's values. Equations of the type

$$n\text{-butane} = 2 \times \text{propane} - \text{ethane}$$

can be set up, and good agreement of estimated and observed free energies obtained when the equations show an identity of groups on each side.

In deriving the resonance energy of aromatic compounds, the Pauling method employs bond-energy values for C—C and C=C which are characteristic of aliphatic compounds. A similar extension cannot be made to calculate the resonance free energy of an aromatic compound. The referring of bond or group values derived from the aliphatic to the aromatic series involves a reaction in which there is an increase in the entropy of translation. This can be estimated, and the entropy decrease then remaining can be attributed to the increase in symmetry and the decrease in the number of internal rotations. When these factors are allowed for in a reaction yielding benzene, for example,

$$3 \times \text{cyclohexene} = \text{benzene} + 2 \times \text{cyclohexane}$$

there remains an *additional* small entropy decrease, which may be referred to as the resonance entropy of benzene. The estimated value of this resonance entropy is about 4 cal./degree.

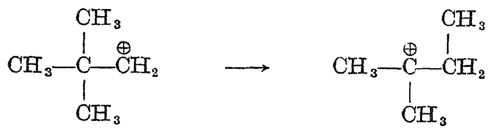
The afternoon session, during which Prof. M. G. Evans acted as chairman, opened with a paper by Dr. A. G. Evans on "Ionization Energies of Carbon-halogen Bonds, and Proton Affinities of Olefines". The speaker began by describing the reactions of organic halides in solution, which involve substitution at a saturated carbon atom. Two possible mechanisms have been established by Ingold and co-workers—a unimolecular S_N1 mechanism and a bimolecular or S_N2 mechanism.

It has been found experimentally that the unimolecular S_N1 reaction-rate of R—X *increases* along the series of R=Me, Et, *sec.*-Pr, *t.*-Bu, whereas the bimolecular S_N2 reaction-rate *decreases* along the same series.

An explanation of these facts can be given in terms of the activation-energies associated with both mechanisms, as derived from potential-energy curves. The prime factor favouring S_N1, in passing from Me $\rightarrow$ *t.*-Bu, is the great increase in the ease of ionization of the R—X bond, due to the marked fall in the ionization potential of the radical R. The decrease in the S_N2 rates, from Me $\rightarrow$ *t*-Bu, can be accounted for satisfactorily in terms of the carbon-halogen bond-strengths and steric hindrance.

Dr. Evans showed how the values of the ionization potentials of hydrocarbon radicals, coupled with bond-breaking energies derived from substitution heats, can be combined to estimate the proton affinities of olefines. The calculated affinities show that carbonium ions are markedly more stable when the positive charge is located on a tertiary, or on a secondary, carbon atom than when it is on a primary carbon atom. The energy differences are sufficiently large to allow isomerization to take place.

This effect is illustrated in the neopentyl derivatives, in which all reactions of the carbonium-ion type yield exclusively rearranged products which are all accounted for if the ion rearranges thus:



Other examples of such isomerization frequently occur in the Friedel–Crafts reaction. The 'peroxide effect' for hydrogen bromide addition to double bonds, which constitutes an exception to the Markownikov rule, was discussed in terms of bond-energies.

The determination of bond-energies by spectroscopic methods was outlined in the next contribution, by Dr. H. D. Springall, on the "Spectroscopic Evidence on Bond-Energies". Dr. Springall pointed out that the estimation of the heat of formation from atoms (Q_a) of an organic compound requires a prior knowledge of the energies of dissociation (D) of a number of common diatomic molecules—particularly H_2, O_2, N_2 and CO. The latter is important in determining the value of the latent heat of sublimation of carbon, L.

To evaluate D for a diatomic gas, it is necessary to examine the vibrational energy-levels of the ground-state, and to evaluate the energy difference between the lowest state ($V=0$) and the onset of the dissociation continuum ($V=V_c$). From an analysis of a suitable vibrational spectrum, it is usually possible to trace the vibrational-levels in the ground-state from $V=0$ to $V=c.\ 20$. It is not, however, normally possible to observe up to $V=V_c$ directly. Owing to the anharmonic nature of the vibrational motion, the energy difference ΔE_v between successive levels is, to a first approximation, a linear function of V, so that V_c may be evaluated by the Birge–Sponer method of plotting ΔE_v against V for the observed range, and extrapolating to $\Delta E_v \rightarrow 0$, when D is given by the area under the curve. D may also be estimated by plotting $E_v - E_0$ against ΔE_v, and extrapolating to $\Delta E_v \rightarrow 0$.

At the present time, the D values for H_2 and O_2 are known with certainty (H_2, 4·46 eV.; O_2, 5·08 eV.), but values for N_2 and CO are still ambiguous. In both these cases, two alternatives exist: CO, 9·14 or 11·11 eV.; N_2, 7·38 or 9·76 eV. The most recent analysis based on the application of the Hund non-crossing rule, by Gaydon and Penney, favours the higher values in each case. The corresponding heats of atomization (ΔH_{298}) are

$$
\begin{aligned}
\text{C graphite} &= 126 \cdot 2 \text{ or } 171 \cdot 6 \text{ kcal.} \\
\tfrac{1}{2}H_2 &= 51 \cdot 8 \text{ kcal.} \\
\tfrac{1}{2}O_2 &= 59 \cdot 1 \text{ kcal} \\
\tfrac{1}{2}N_2 &= 85 \cdot 5 \text{ or } 113 \cdot 0 \text{ kcal.}
\end{aligned}
$$

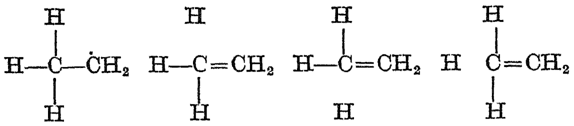
Dr. E. Warhurst concluded the afternoon session with a paper on the "Quantum Mechanical Theory of Bond-Energies". The gradations in the bond-energies in a series of compounds $R—X$ have been explained qualitatively by the concept of resonance, in a theoretical treatment given by Baughan, Evans and Polanyi. The main factors influencing the $C—X$ bond-strength in a series of $R—X$ compounds are:

(i) the resonance-energy of the radical R;
(ii) the ionic-covalent resonance energy from the interaction of the structures $R—X$ and $\overset{+}{R}\overset{-}{X}$.

One type of resonance of the free radical is well known, namely, that in an unsaturated or conjugated group; for example,

$$\text{allyl radical } \underset{\text{(i)}}{CH_2 = CH — \dot{C}H_2} \quad \underset{\text{(ii)}}{\dot{C}H_2 — CH = CH_2}$$

A second type of resonance, first mentioned by Wheland, is possible in radicals of the saturated hydrocarbons. The ethyl radical, for example, can be represented by four structures,



(i) (ii) (iii) (iv)

between which resonance can occur. The number of canonical states increases with the complexity of the radical: there are seven for *sec*-propyl, and ten for *t*.-butyl.

If there were no interaction with the ionic state $\overset{+}{R}\overset{-}{X}$, then the changes in the bond-strength $C—X$ in a series $R—X$ would be equal to the changes in the radical resonance energy R_r of the radical. In the case of C—H bonds, where the ionic contributions are relatively small, there is a close parallelism between the C—H bond-breaking energies and the calculated R_r values, the bond-energies falling as the R_r values increase.

In most cases there is an appreciable resonance energy R_{ih} between the ionic and covalent states, and this factor operates in the direction of strengthening the $R—X$ bond. The net strength of the $R—X$ bond is accordingly determined by the balance between the weakening effect of radical resonance energy and the strengthening effect of the ionic resonance term. In the C—I bonds, the fall in bond-energy from Me—I to *t*.-Bu I is less than the fall in the C—H bond energies from Me—H to *t*.-Bu—H, which agrees with our experience of the greater ionic character of C—I relative to C—H bonds. The strengths of the C—O bonds, from Me—OH to *t*.-Bu—OH, show very little, if any, fall down the series. Here the ionic character of the C—O bonds is increasing sufficiently from MeOH to *t*.-BuOH completely to offset the weakening effect of the radical resonance.

Periods of approximately thirty minutes were given to discussion of each paper, during which several valuable points illustrating the application of the general theory in reactions of industrial importance were made. H. A. SKINNER

[1] See *Nature*, **156**, 638 (November 24, 1945).

CARBON SOURCES IN THE PHOTOSYNTHESIS OF AQUATIC PLANTS

By PROF. E. STEEMANN NIELSEN
Botanical Department, Danish Pharmaceutical Highschool

WHEREAS the carbon dioxide of the air as the carbon source in the photosynthesis of terrestrial plants has been known since the end of the eighteenth century, matters are quite different as regards the carbon supply of aquatic plants.

It was assumed by Nathansohn[1] that aquatic plants are able to utilize half of the carbon dioxide of bicarbonate in the surrounding water, while at the same time carbonate develops. He was of opinion that only carbon dioxide was directly assimilated, carbon dioxide being constantly released anew from the bicarbonate when the former was removed by the plants.

Another view, however, was advanced by Angelstein[2], according to which aquatic plants were not only able to utilize the carbon dioxide in true solution, but also were able to use the bicarbonate directly in photosynthesis.

The view of Angelstein was supported by experimental work by Arens[3] on directed transfer of ions through the leaves of water plants. $Ca(HCO_3)_2$ is consumed on the lower surface of the leaf, while an equivalent quantity of $Ca(OH)_2$ ions emerges at the upper surface. By means of a series of growth experiments, I showed[4] that bicarbonate may be an absolutely decisive direct carbon source in the photosynthesis of aquatic plants.

On the other hand, James[5] showed that the aquatic moss *Fontinalis* is unable to utilize bicarbonate directly. This is in accordance with experiments made on the same plant in the present investigation As will be shown, *Fontinalis*, however, holds a special position.

In his admirable and important book on photosynthesis, Rabinowitch[6], if anything, supports the view that bicarbonate is not used directly by aquatic plants. He does not feel quite sure of the reliability of Arens' experiments. But owing to the War, Rabinowitch was unaware of my work.

Experiments described herewith throw light on the qualitative and quantitative importance of carbon sources in the photosynthesis of aquatic plants. A full account will appear later in *Dansk Botanisk Arkiv*.

In Fig. 1 curves for the photosynthesis of *Myriophyllum spicatum* in optimal light (37,000 lux, 20° C.) partly with carbon dioxide in true solution (upper curve), partly with HCO_3 as carbon source (lower curve, full line) are drawn together, the total carbon dioxide in 10^{-3} mol/l. being marked along the abscissa. In the experiments with free carbon dioxide as the carbon source the amount of HCO_3^- present was without any importance whatever, pH being 4·6, at which hydrogen ion concentration only about one per cent of the total carbon dioxide occurs as HCO_3^- ions. As these have, as will appear, a much smaller effect on the photosynthesis even than free carbon dioxide, we may completely disregard the presence of HCO_3^-.

The bicarbonate curve (pH 8·3) is corrected for the effect of the carbon dioxide in true solution present (see dotted curve), the intensity of photo-

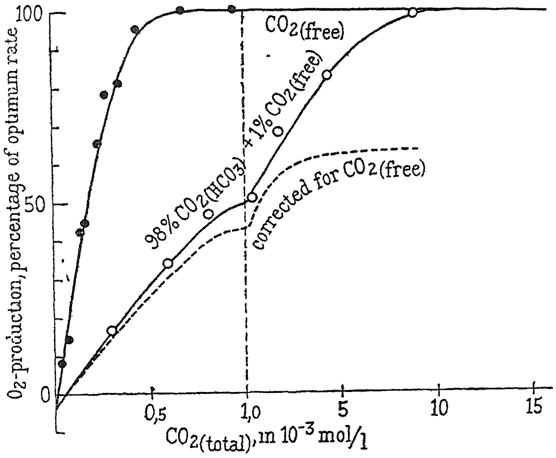


Fig 1

synthesis that would have been obtained from the carbon dioxide in true solution corresponding to the amount of bicarbonate (at pH 8 3, 1 per cent carbon dioxide free) being subtracted from the original curve. At 10^{-3} mol/l. the scale of the abscissæ is changed.

Fig. 1 shows that both free carbon dioxide and HCO_3^- ions can be directly assimilated by *Myriophyllum*. As will be shown below, photosynthesis in this species is independent of the hydrogen ion concentration in the pH range 4–10. At low concentrations of carbon dioxide (total) the effect of free carbon dioxide is about four times as great as the effect of $CO_{2HCO_3^-}$.

Fig. 2 shows the results of similar experiments with *Fontinalis antipyretica* (15,000 lux, 22° C.). In this species there is practically no effect of HCO_3^- ions on photosynthesis.

The *Fontinalis* originated from a locality with a considerable content of free carbon dioxide (order of magnitude $0 \cdot 3 \times 10^{-3}$ mol/l.). From Fig. 2 it appears that it is possible for the plant to maintain considerable photosynthesis at this concentration of carbon dioxide.

The *Myriophyllum spicatum*, on the other hand, originated from a locality with practically no content of free carbon dioxide (order of magnitude 10^{-6} mol/l.). The pH in summer is 9–10. The content of HCO_3^- is 2×10^{-3} equivalents/l. From Fig. 1 it appears that it is possible for the plant to maintain considerable photosynthesis at this HCO_3^- concentration.

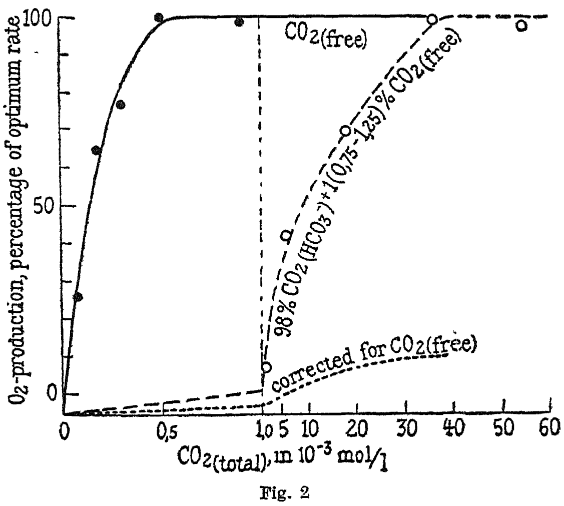


Fig. 2

With free carbon dioxide as carbon source, the intensity of photosynthesis is independent of the ion composition of the water (see accompanying table).

RELATIVE PHOTOSYNTHESIS IN *Myriophyllum* AT 2×10^{-4} MOL CO_2/l 37,000 LUX, 20° C, pH 4 1

Cations	Anions	Relative intensity of photosynthesis
H^+	Cl^-	102 ± 2
H^+, K^+	Cl^-, SO_4^{--}	101 ± 2
H^+, K^+, Na^+, Ca^{++}	Cl^-, SO_4^{--}	100 ± 2

The intensity of photosynthesis in *Myriophyllum* with HCO_3^- as carbon source, on the other hand, is very dependent on the ion composition, both cations and anions asserting themselves (see Fig. 3). The best result at a certain HCO_3^- concentration is obtained in lake water from the habitat of the species. In a pure $KHCO_3$ solution (10^{-3} mol/l.) the photosynthesis is only 42 per cent of that in lake water with the same HCO_3^- concentration (same pH), By simultaneous addition of, for example, Ca^{++} and K^+ ions an

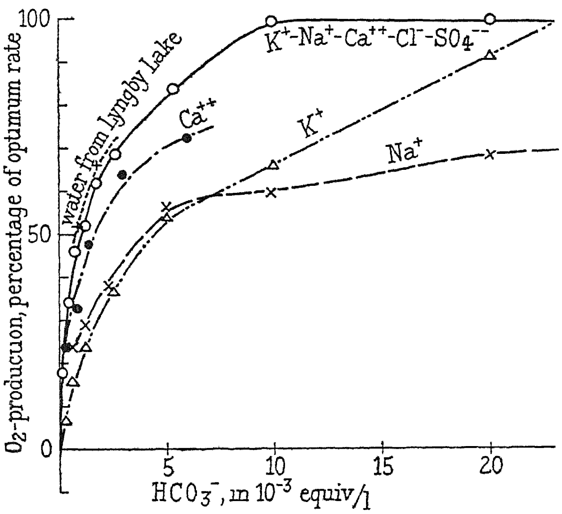


Fig. 3

intensity of photosynthesis of 79 per cent of that in the lake water is obtained. The quantitative importance of the cations and anions was also investigated. It is the absolute amounts of the various ions which are of importance, not the proportions between the various ions. A further addition of a definite ion is of no importance when the optimum effect of this ion is reached.

In the pH range 8 to somewhat above 10 the assimilation of HCO_3^- in *Myriophyllum* is independent of the hydrogen ion concentration in natural lake water (Fig. 4, upper curve). In the pure $KHCO_3$ (K_2CO_3) solution there is some increase of the photosynthesis with a rise of pH at lower concentrations of HCO_3^- (Fig. 4, lower curve), whereas at high HCO_3^- concentrations there is instead a very considerable reduction of the intensity of assimilation, the factor of time, however, asserting itself highly. Below pH 8 it is impossible to undertake investigations of the dependence of the assimilation of HCO_3^- on the hydrogen ion concentration, as the concentra-

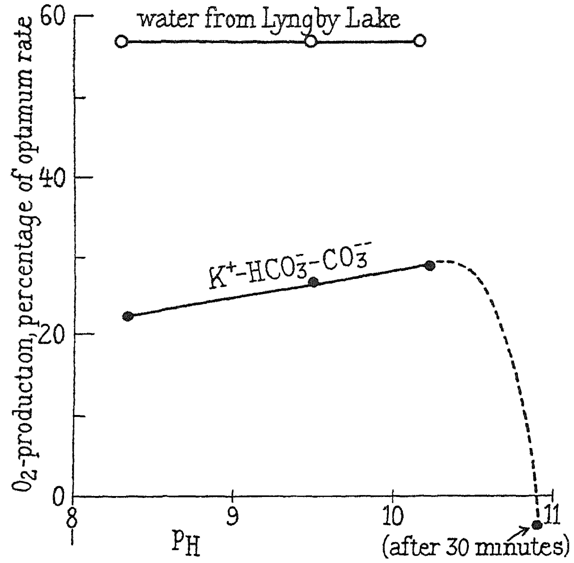


FIG 4 CONCENTRATION OF HCO_3— 10^{-3} EQUIVALENTS/L

tion of carbon dioxide in true solution becomes too high.

For similar reasons it is only possible to investigate the importance of the hydrogen ion concentration to the assimilation of free carbon dioxide at *p*H values below about 5. Down to a *p*H value a little above 3 the photosynthesis in *Myriophyllum* is independent of the hydrogen ion concentration (Fig. 5). At a

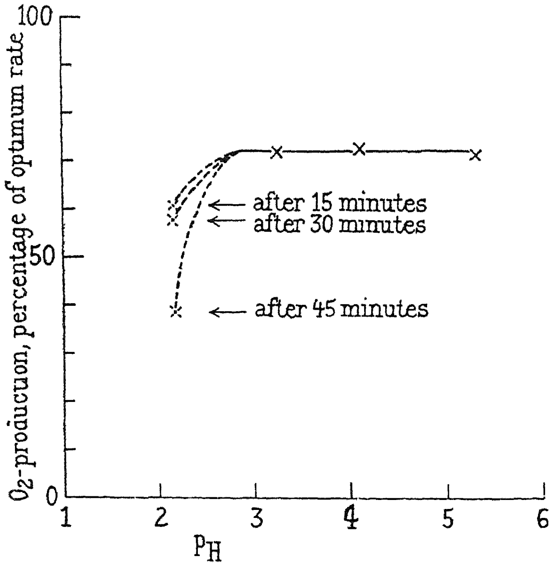


Fig. 5. CONCENTRATION OF FREE CARBON DIOXIDE $3{\cdot}2\times10^{-4}$ MOL/L.

still lower *p*H value the hydrogen ions have a detrimental effect on the assimilation of carbon dioxide. This poison effect increases with time.

[1] Nathansohn, A., *Ber sächs Ges d. Wiss.*, **59**, 211 (1907).
[2] Angelstein, W., *Beitr. Biol d. Pfl*, **10**, 87 (1910).
[3] Arens, K, *Jahrb. f wissensch Bot*, **83**, 513 (1936).
[4] Steemann Nielsen, E., *Dansk Bot. Ark.*, **11**, No. 8 (1944).
[5] James, W. O., *Proc. Roy Soc.*, B (1928).
[6] Rabinowitch, E. J, "Photosynthesis and Related Processes", Vol. 1 (New York, 1945).

MARINE ALGÆ OF NEW ZEALAND

By PROF. V. J. CHAPMAN
Auckland University College

THE publication in the near future of a revised list of the Phæophyceæ of New Zealand serves to emphasize the relative inadequacy of our knowledge of the marine flora of antarctic waters, and it indicates that there is a wide field open to research The list will include a number of new species, and they will for ever stand as a tribute to the untiring labours of the author of the paper (Mr. W. V. Lindauer), who is one of the leading algologists in the southern hemisphere. In spite of the progress made as a result of Mr. Lindauer's labours, there is little doubt that still more species remain to be added to the algal flora of New Zealand Some of these will be species already known from other parts of the world, but there will also be species new to science. The publication of this list should serve, among other things, to stimulate work in New Zealand on the validity of some of the species recorded, especially those characteristic of the northern hemisphere, for example, *Cutleria multifida*. Although this species is at present retained in the list, there is some doubt as to whether the *Cutleria* found in New Zealand is really this species or whether it is not an entirely different one However, plants are not very common and appear to be variable, so that until further collections are available a decision cannot yet be made.

Among the new plants listed by Mr. Lindauer are unnamed (for the moment) new species in each of the genera *Hecatonema*, *Mikrosyphar*, *Herponema*, *Spatoglossum* and *Tinocladia*, together with the following species new to science: *Leathesia nova-zelandia*, *Nemacystis nova-zelandia**, *Papenfussiella lutea**, *Myriagloia lindaueri**, and *Dictyota papenfussii*.

When compared with the earlier lists published by Laing, it will be noticed that a number of species of doubtful occurrence have disappeared and certain changes in nomenclature have been made. In the latter category the most important change is that of *Cystophora* for *Blossevillea*, because so many workers are used to the former name. It seems evident, however, that according to the rules of priority this change must be made. Altogether, the list contains seven species new to science and twenty-seven new records for New Zealand, together with an additional sixteen species bearing a change of name.

Among species which require further investigation is *Desmarestia firma*, which seems very little removed from *D. herbacea* of the north-west Pacific, the name being retained to some extent on the grounds of the wide geographical discontinuity. *Pylaiella* (*Bachelotia*) *nova-zelandia* also requires further study because the present writer believes that at least two species are included under this name. The species of *Halopteris* await additional study, which will no doubt be forthcoming from the laboratory where Miss L. B. Moore is working.

In the other principal algal groups, although no new lists are being published, advances have been made. Two species of *Monostroma* are now recorded (one new to science) and one species of *Rhizoclonium*. The species of *Chætomorpha* still present some puzzles, as also do the genera *Ulva* and *Cladophora*. In the Chlorophyceæ, Mr. Lindauer has also recorded species

* Published by Kylin from material supplied by Mr Lindauer.

new to science, and the genus *Codium* now contains three such members.

It is probable that the greatest increase in the number of species new to New Zealand will be forthcoming from the Cyanophyceæ, because so far they have not been studied intensively. However, in view of the wide distribution of many of the marine Cyanophyceæ it is unlikely that many of these will be new to science.

The Rhodophyceæ have not been neglected by Mr. Lindauer, and in this sub-division he has recorded at least eight species new to science since the publication of Laing's last list. The red algæ form the largest portion of the New Zealand algal flora, and they will need further careful study before complete discrimination of all the species recorded is finally achieved.

FORESTRY IN NEW ZEALAND

IN the annual report of the New Zealand State Forest Service to March 31, 1945 (E. V. Paul, Govt. Printer, Wellington, 1945), a detailed statement of post-war forest policy is given, evidencing the importance attached to this branch of the national economy. The chief problems are connected with the indigenous forests, the large areas of exotic plantations, and fire protection and soil conservation, the latter of a gravity now becoming recognized in many other parts of the world.

The evolution of a sylvicultural system for rimu is still the outstanding problem in the management of the indigenous forests of New Zealand. Although it was believed that its sylviculture should be simple, this is not so ; it does not 'seed' freely, and seedlings are intolerant of light and drought. It is hoped to undertake special investigations on these subjects.

Assessment surveys and sample plot investigations have been actively pursued as a basis of working plans for all the State exotic forests, which are regarded as essential to the development of a sound national forest policy. The total annual growth in the exotic forests seems to be very much less than commonly believed, and it will be necessary to limit sawn-timber production in the immediate future to safeguard requirements in high-grade timber.

The results both of assessment surveys and of trials in the sawing, drying and utilization of young *Insignis* pine timber for house building have clearly demonstrated the bad effect of 8 ft. × 8 ft. planting on stands of this pine in the pumice lands of the Bay of Plenty and Taupo districts, and the wisdom of the Department in reverting to closer spacings. To produce a significant proportion of heart as well as defect-free timber, every compartment of *Insignis* pine which can be treated by appropriate sylvicultural measures should be managed on at least a forty years rotation and some even on a seventy years rotation.

Observations upon clear-felled areas of *Insignis* pine in the Rotorua Conservancy show that natural regeneration cannot be relied upon even in that district ; results appear to vary with aspect, exposure, etc. On some of the more recently felled areas on the Whakarewarewa State Forest, and on even the oldest areas in the Waiotapu State Forest, natural regeneration has been so unsatisfactory that further investigations are necessary of light burning operations as an aid to regeneration and the possible reversion to planting operations for re-establishment.

In land acquisition the Forest Service has continued its long-established policy of avoiding the enclosure of extensive areas of good farming land, but it requires small areas of good-quality soil for exotic hardwoods, the more extensive planting of which is to be undertaken as a post-war project.

For twenty-five years the Forest Service has successfully protected against fire some 15,000,000 acres of State forest, Crown lands, native lands, national parks, etc. This is claimed to be the greatest single contribution by any one national body to the conservation not merely of New Zealand's forest wealth alone, but also of the great soil and water resources of the Dominion. This policy is being continued, and is being supported by numerous Catchment Boards set up during the year under the Soil Conservation and Rivers Control Act, 1941. Co-operation by Maori interests, by forestation and sawmilling companies, and by local bodies is being continually sought and obtained.

It was hoped that the whole of the expansion in timber production required for the post-war period could be met by the exotic forests. An exhaustive series of trials in the logging, milling, drying, grading and utilization of young *Insignis* pine timber for house-framing has shown that this will not be possible. Due principally to the use of wide planting espacements and failure to prune and thin at appropriate times, trees have grown such heavy branches that the sawn timber, boards and scantling, etc., are characterized by large knots of 1½ in. or more in diameter, and much is unsuitable for building purposes.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 28

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 3 p m —Field-Marshal Viscount Montgomery of Alamein, G C B "Morale—with Particular Reference to the British Soldier" (Lloyd Roberts Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m.—Discussion on "Electricity" (to be opened by the President).

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Manchester), at 6.15 p m —General discussion on "Anti-oxidants".

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St James's Park, London, S W 1), at 6 30 p m.—Mr A. Rodgers · "The Pressurization of Aircraft Cabins".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the AGRICULTURE AND FOOD GROUPS, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 30 p.m.—Prof G L. Baker "Agricultural Delaware and its Supporting Research" ; Prof. J. A Scott-Watson "Agricultural Research and Farming Progress".

Tuesday, October 29

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 15 p m —Prof. James Gray, F.R S "Locomotory Mechanisms in Vertebrate Animals, 1, Aquatic Locomotion Fins as Propellers; Brakes and Mechanisms of Directional Control" *

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W C 1), at 5 30 p m —Dr Redcliffe N. Salaman, F.R S. "The Potato as a Factor in Social Structure".

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C 2), at 6 p.m.—Mr F H. Townsend, Mr G. B Goff and Mr. S. R Kharbanda : "An Improved Television Signal Generator and its Uses"

CHEMICAL SOCIETY, SOCIETY OF CHEMICAL INDUSTRY and ROYAL INSTITUTE OF CHEMISTRY, EDINBURGH AND EAST OF SCOTLAND SECTIONS (joint meeting with the EDINBURGH UNIVERSITY CHEMICAL SOCIETY, in the Biochemical Lecture Theatre, The University, Teviot Place, Edinburgh), at 7 p.m —Dr. D J. Bell : "Some Observations on Biological Oxidation and Reduction".

TEXTILE INSTITUTE, LANCASHIRE SECTION (at 16 St. Mary's Parsonage, Manchester 3), at 7 p m.—Mr C W. Bradley · "Some Applications of Photography to Textile Research".

Wednesday, October 30

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Symposium on "Direction-Finding".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (at the Royal Society of Medicine, 1 Wimpole Street, London, W 1), at 6 30 p m —Prof A C Fraser "Adsorption and Digestion of Fat"

BRITISH ASSOCIATION OF CHEMISTS, LONDON SECTION (at Gas Industry House, 1 Grosvenor Place, London, S W 1), at 7 p m — Mr. H C Stephenson: "Protection Against Industrial Poisons"

ROYAL INSTITUTE OF CHEMISTRY (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 7 p m —Prof Alexander Findlay "Students and the Royal Institute of Chemistry"

SHEFFIELD METALLURGICAL ASSOCIATION (in the Victoria Hall, Sheffield), at 7 30 p m —Dr T E Allibone "Atoms, Electrons and Engineers" (Faraday Lecture, by invitation of the Institution of Electrical Engineers).

SOCIETY OF VISITING SCIENTISTS (at 5 Old Burlington Street, London, W 1), at 7 30 p m —Discussion on 'The Outlook in Biology" (to be opened by Prof J Z Young, F R S , and Dr D Pontecorvo)

Thursday, October 31

IMPERIAL INSTITUTE, MINERAL RESOURCES DEPARTMENT (in the Cinema Hall, Imperial Institute, South Kensington, London, S W 7), at 3 p m —Mr C B Bisset · "Recent Progress in Geological Investigation and Mineral Developments in the Colonies, 5, The Work of the Geological Survey of Uganda" *

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p m —Prof. J. R. Partington "History of Alchemy and Early Chemistry, 1" *

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p m —Prof A R. Collar "Aeroelastic Problems at High Speed".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m —Prof. Jaroslav Heyrovsky "The Fundamental Laws of Polarography".

ROYAL STATISTICAL SOCIETY, SHEFFIELD GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in Room B1, Department of Mechanical Engineering, The University, St George's Square, Sheffield 1), at 6 30 p m —Mr J Bradwell "The Control of Coke Quality by the Shatter Test".

Friday, November 1

CHEMICAL SOCIETY, SOUTH WALES SECTION (joint meeting with the UNIVERSITY COLLEGE OF SWANSEA CHEMICAL SOCIETY, at University College, Swansea), at 6 p.m.—Prof. D. H. Hey "Hæmolytic Reactions".

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION (at University College, Gower Street, London, W.C.1), at 6.30 p m.—Sir Philip R Morris . "The Psychologist's Contribution to Educational Progress".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (at the College of Technology, Manchester), at 6 30 p m.—Lecture by the Rt. Hon. Lord Piercy

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 9 p.m.—Dr. Percy Dunsheath : "New Problems in Electrical Engineering".

Saturday, November 2

BIOCHEMICAL SOCIETY (joint meeting with the SOCIETY FOR GENERAL MICROBIOLOGY, at the London School of Hygiene, Keppel Street, London, W.C.1), at 11.15 a.m.—Discussion on "Quantitative Biochemical Analysis by Microbiological Response".

GEOLOGISTS' ASSOCIATION (at the City Literary Institute, Stukeley Street, London, W.C 2), at 2 30 p m —Annual Reunion

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned .

FOUNDRY TECHNICAL OFFICERS to conduct research projects at Sheffield and other steel-making centres—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1 (November 1).

LECTURER IN CHEMISTRY in the Coventry Technical College—The Director of Education, Education Offices, Coventry (November 2).

ASSISTANT IN THE MECHANICAL ENGINEERING DEPARTMENT—The Principal and Secretary, Harris Institute, Preston (November 2).

LECTURER IN PHYSICS—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (November 4)

HEAD OF THE CHEMISTRY AND METALLURGY DEPARTMENT at Swansea Technical College—The Director of Education, The Guildhall Swansea (November 5)

SENIOR ASSISTANTS IN THE ELECTRICAL ENGINEERING DEPARTMENT —The Secretary, Northampton Polytechnic, St John Street, London, E.C.1 (November 8).

EDUCATIONAL PSYCHOLOGIST for work in connexion with the Child Guidance Service—The Clerk of the County Council, Shire Hall, Dorchester (November 9).

LECTURER IN THE DEPARTMENT OF CHEMISTRY in the Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (November 9).

SUPERINTENDING ENGINEER in the Radar Research and Development Establishment of the Ministry of Supply—The Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1656 (November 14).

LECTURER IN MATHEMATICS—The Secretary, Queen's University, Belfast (November 15).

PHYSICIST to take charge of a testing laboratory—The Wool Industries Research Association, Torridon, Headingley, Leeds 6 (November 16)

CHIEF OF THE DIVISION OF SOILS (headquarters at the Waite Agricultural Research Institute, Adelaide), Council for Scientific and Industrial Research—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W C 2, quoting No 932 (November 18)

OFFICER-IN-CHARGE of the Dairy Research Section, Council for Scientific and Industrial Research, Melbourne—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W C 2, quoting No. 1009 (November 18).

RESEARCH OFFICER IN THEORETICAL PHYSICS, Division of Industrial Chemistry of the Council for Scientific and Industrial Research, Melbourne—The Secretary, Australian Scientific Research Liaison, Australia House, Strand, London, W C 2, quoting No 1004 (November 18).

PRINCIPAL OF THE KEIGHLEY TECHNICAL COLLEGE—The Acting Borough Education Officer, Keighley, Yorks (November 18)

LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, Queen Mary College, Mile End Road, London, E 1 (December 21)

AGRICULTURAL ECONOMIST on the staff of the Senior Agricultural Economist in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Department of Agriculture and Lands, P.O Box 387, Salisbury Southern Rhodesia (December 31)

RESEARCH ASSISTANTS (2, temporary) for work on composts and organic fertilizers—The Registrar, The University, Reading

GLASS-BLOWER AND STEWARD IN THE DEPARTMENT OF CHEMISTRY, University of Cape Town—The Secretary, Overseas Department (Ref 18885), Ministry of Labour and National Service, Norfolk House, St James's Square, London, S.W.1

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PRINCIPAL OF THE NEWTON RIGG FARM SCHOOL (graduate in Agriculture or appropriate sciences, with teaching experience and sound practical experience on farms)—The Director of Education for Cumberland and Secretary to the Farm School Governors, County Education Offices, Portland Square, Carlisle

LECTURER (man or woman) IN PHARMACEUTICAL SUBJECTS in the Plymouth and Devonport Technical College—The Director of Education, Education Offices, Cobourg Street, Plymouth

LECTURER IN MINING—The Principal, County Mining and Technical School, Nuneaton, Warwickshire.

LECTURER IN PHYSICS to Final B.Sc standard—The Organiser of Further Education in Rugby, College of Technology and Arts, Eastlands, Rugby

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SOCIAL STRUCTURE IN NEW TOWNS

ALTHOUGH the daily and the technical press have given it little attention, the final report of the New Towns Committee, under the chairmanship of Lord Reith (London H M. Stationery Office, 1946. 1*s* 3*d*. net), is a much more important document than the two interim reports. Whereas the interim reports were addressed primarily to the Minister of Town and Country Planning and the Secretary of State for Scotland, the final report is written also for the corporations which will promote new towns and for the general public. Summarizing the contents of the earlier reports, it deals both with the issues which are peculiar to new towns and with many which are common to all forms of new development. Some of the ideas and principles that it lays down for the guidance of those who will bear the responsibility of creating new towns may seem obvious, but the almost daily examples that are encountered of the neglect of the obvious by private developers, the planning authorities even of great cities, Government departments, and even such bodies as the National Trust, not only provide justification for the inclusion of such reminders but also indicate the wide audience whose attention the report can rightly claim.

It is this concern, not only with the physical tasks involved and with the devising of appropriate machinery to handle them, but also with the more complex and delicate problem of founding the social structure of a new town and fostering its corporate life, that gives the final report of the Reith Committee such general interest. The problem touches every citizen, for it is a social enterprise, demanding, if it is to be well done, not merely the exercise of techniques common to other forms of development and the co-operation of specialists in various fields, but also the close and continuous scrutiny and support of a really well-informed and vigilant public opinion.

Some of the Committee's recommendations relate to the establishment of towns on entirely new sites rather than the transformation of existing small communities ;* and the observations on the size and social structure of new towns, the qualifications of the chief officers of a corporation and the necessity for a central advisory commission, are at variance with the present practice of the Minister of Health. Not that the Committee's recommendations imply any one standardized pattern of physical or social structure : the Committee recognizes that, after standards have been adopted safeguarding the basic human needs of space, air and light, there is ample room for variations in local density and for meeting personal preferences. Satisfying such preferences, indeed, affords opportunity of avoiding architectural monotony and adding to the interest of a town. New ideas continually emerge, and the Committee urges that those responsible for new towns should never be afraid of experimenting, even at the cost of occasional mistakes.

In this final report the Reith Committee suggests a wide range of amenities that should be provided in new towns. Even though all amenities cannot be provided at once or as soon as the local community is sufficient to support them, it is important to plan ahead for them, and to reserve sites for all amenities that will ultimately be required. Elsewhere in the report there is stressed the importance of the development authority refraining from the usual error of starting on important projects before the detailed plans are properly worked out. While there is no suggestion of over-planning in this report, the Committee emphasizes, and rightly, the necessity for methodical and careful planning before initiating projects, and for adherence to whatever long-term plan has been approved and initiated.

The principles to be considered in preparing such plans are clearly but concisely set out They indicate the Committee's own preference for new towns on relatively undeveloped sites, and considerable force has since been lent to its view, that the difficulties which will arise in carrying out the major extension of a small town have not been fully appreciated, by what has already arisen over the Manchester proposals with regard to Mobberley, for example. Apart from the difficulties arising out of interference with existing interests and relationships, there is substance in the Committee's contention that there are regions in England, Wales and particularly Scotland, of low density and remote from any large centre, where a new town would confer great benefit, especially on the surrounding agricultural population, by affording alternative employment to some members of the family, and by bringing within easy reach the amenities and facilities of modern civilization. Omission of any such site from those already announced in Scotland has been strongly criticized, the Border counties being cited as providing the appropriate locality; and the dissatisfaction with the Minister's policy on this point will be the more general if, as now appears from Mr. Silkin's reported statement at the conference of the Institute of Housing on September 27, not more than seven and a half per cent of the population to be rehoused in the next ten years will be accommodated in new towns. If that proves to be true, the primary purpose of the New Towns Act will have been served only to an insignificant extent, and cities like Manchester will be driven to continued suburban sprawl.

Beyond this, it is at least open to question whether adequate weight has been given in the selection of the sites already named for new towns to the factors determining the size of a new town which are set forth in this final report, more particularly those governing its lower limit. Equally it would appear that there is real danger that the extent to which doctrinaire considerations influence, if they do not dominate, Mr. Bevan's building policy, will militate against the establishment of the balanced social structure advocated by the Reith Committee. If the community is to be truly balanced, so long as social classes exist, all must be represented in it. A contribution is needed from every type and class of the people; the community will be the poorer if all are not there, able and willing to make their contribution.

The Committee in this important passage of it report refers to the desirability of business and industries established in the new towns including not only factories, shops and services meeting local needs, but also administrative and research establishments, including sections of government departments. Directors and executives, for example, should live in the town and take part in its life. Professional men and women, writers, artists and others not tied to a particular location, as well as retired people, should find a new town a good place in which to live and work. To attract and retain all these groups, the character of the town as one of diverse and balanced social composition must be established at the start, and without mentioning the Government's present housing policy, the report indicates clearly enough how disastrous may be the consequences if all the dwellings built in the early years are of a minimum standard. Once the balanced character of the population is established, it will be relatively easy to maintain; but conscious and sustained policy to this end on the part of the agency itself and of the leaders of local industry and commerce and social activity will be as essential as a sympathetic and flexible policy and active support from the central Government itself, in ways that are indicated in what has already been said.

There are other matters on which some reassurance from the Government might well be forthcoming. In regard to the selection of sites, reference is again made to the importance of further research so that national considerations may be taken fully into account in formulating policy. Again, areas of exceptional natural beauty or great historic interest should be avoided if their character would be impaired by the siting of a town, though the Committee recognizes that a new town need not of itself destroy the beauty of the normal countryside—it may enhance it and bring more people within reach of enjoyment of it. Special care should be taken to safeguard features of particular beauty near new towns; and in regard to main zoning, while a disorderly mixture of land uses is anathema, in a town under unified land ownership it would be wrong to go to the other extreme and plan the land in advance too precisely. Factories, for example, should be segregated for technical reasons and for amenity; but they should be within easy walking or cycling distance of residential neighbourhoods. Similarly, the Committee points out that administration of the necessary control of design must not be oppressive; it requires a judicious blend of firmness and flexibility, but in its decisions the agency must be advised finally by one person; matters of taste cannot be determined by a team.

Throughout this admirable report, which forms a text-book on how to build a new town, there is a strong vein of common sense. There is vision as well, and the magnitude and the opportunity of the task which confronts a development corporation are clearly displayed. Some of the distinctive problems of the new towns policy might indeed have been discussed more fully. The methods by which a corporation could most effectively enlist the co-operation of the people of a new town in its work;

the problems of moulding a community in which there is no geographical or cultural segregation of social classes; and the relation of the building of new towns to a policy of urban decentralization—these are all problems needing attention and on which the Government itself has given as yet little guidance.

There is, it is true, little that is original in the report, though the review of the social, cultural and recreational facilities required in a new town contains food for thought for many concerned with such activities in existing towns also. It is the emphasis given to the factors that is so important, and the report should, moreover, dispel any illusions that the building of new towns offers any contribution to the alleviation of the immediate housing situation. It will be desirable to construct public utilities and build some factories and shops in advance of major housing developments. This means that, during the first three years, comparatively few permanent residents can move in; that heavy outlay will be necessary at first, yielding a delayed return; that initially it will be desirable to charge low rents for buildings such as shops, with powers to revise them upwards as the town develops; and that the provision of a large constructional force will require special and careful treatment.

It follows, therefore, that the success of a new towns policy will demand the support of an informed public opinion, fully understanding what is involved in the policy and able to resist pressure which sectional interests or those with short-term views may bring to bear on its orderly execution. The Government will rightly be expected to provide the first new towns with a reasonable share of labour, materials and other facilities, and to ensure that the broad trends of national policy promote their efforts. The development corporations will indeed have the means and the power to make the new towns a success, and that in turn will depend largely on the selection and training of men and women of the highest calibre both for membership of the corporations themselves and for the teams of executives to whom the development corporations entrust the preparation, administration and execution of their plans.

MECHANISM OF THE BIOLOGICAL ACTION OF RADIATIONS

Actions of Radiations on Living Cells
By Dr. D. E. Lea. Pp. xii+402+4 plates. (Cambridge: At the University Press, 1946.) 21*s*. net.

THIS book is the most important and authoritative work now available dealing with the simplest and most fundamental actions of ionizing radiations on living cells. The scope is intentionally limited. In the preface the author states clearly that he "thought that a useful purpose would be served by giving a rather detailed discussion of the mechanism of those actions of radiation which are sufficiently well understood for such a treatment to be profitable at the present time".

Everyone working on the biological actions of radiations, including radiotherapists, should read and re-read this book. (The reviewer has read it four times.) Many people will find it difficult, but there can be no doubt as to the desirability of understanding the elementary principles which are examined critically and in great detail in this book.

The approach is biophysical. In the interpretation of the quantitative measurements of the actions of radiations on viruses, genes and chromosomes, the treatment is physical and the algebraic detail is wisely kept in the background. One of the most valuable features of the work is the large amount of relevant information summarized in tables and graphs. Radiobiologists should be grateful for accurate data such as these, applicable to liquid water and other tissue-like materials. At first glance, in some cases, the absolute values of the various physical quantities are not known to the accuracy which the tables suggest; but from the text it is evident that the author has taken great pains to avoid giving to the reader a false impression of accuracy. The tables are presented as a self-consistent set, and the justification for giving four significant figures where the absolute values may be in error by as much as 10 per cent is that the differences are usually very much more accurate than this, and spurious discontinuities are avoided.

The first chapter summarizes the physical properties and dosimetry of different radiations. Further details of some aspects of tissue dose and of the spatial distribution of ionization in tissues are given in the first part of an appendix. The discussion of radiochemistry in Chapter 2 summarizes a large amount of published information in a useful form. Of especial interest are the tabulations of ionic yields in dilute aqueous solution, and the discussion of direct and indirect actions of radiation.

Perhaps the most valuable part of the book is Chapter 3, on the target theory. Much of the treatment is original, including the calculations given in the appendix.

The single ionization type of action is characterized by an exponential survival-dose relationship, independence of time and intensity factors and decreasing efficiency per ion pair, with increasing specific ionization, that is, the dose required to produce the same effect with different radiations increases in the order gamma rays, hard X-rays, soft X-rays, fast neutrons and alpha particles. From the inactivation dose corresponding to 36·8 per cent ($1/e$) survival, the target diameter can be calculated by a number of methods. For many of the macromolecular viruses and bacteriophages, the calculated target diameter for inactivation by a single ionization agrees with the size as measured by centrifugation and filtration methods. In the case of larger viruses such as vaccinia, the single spherical target theory is not applicable, and the radio-sensitive volume is only a small fraction of the total. In 1942, Lea and Salaman suggested that vaccinia virus should accordingly be regarded as a single-celled organism containing a number of discrete structural units analogous to genes, and shortly afterwards Green, Anderson and Smadel demonstrated internal structures within vaccinia virus particles by electron micrography.

Genetical effects of radiations, including ultraviolet light, are discussed in Chapter 5, which includes a useful introduction to the aspects of genetics afterwards examined. The work of Lea and his collaborators on enzyme and virus inactivation is discussed. Calculations of the target diameter for mutation are made, showing that the most probable value of the average gene diameter in *Drosophila* is 4–8 mμ.

The production of structural changes in chromosomes by radiations is examined in great detail in Chapters 6 and 7. Again, much of the treatment is based on the investigations of the author and his colleagues. One point of great interest is the account of the prediction and experimental confirmation of the maximum of the number of primary chromatid breaks per cell per roentgen in the region of soft X-radiation near the wave-length 4 A.

The well-known phenomena of delayed division and lethal effects are considered in the last two chapters. The killing of bacteria and of large viruses can be regarded as lethal gene mutations. However, "in those organisms in which chromosome structural changes, as well as lethal actions, have been investigated, namely, *Drosophila* sperm and eggs, *Tradescantia* pollen and bean root tips, fairly strong evidence, though at present circumstantial evidence, has been presented for the view that the main cause of the lethal effect is the production of types of chromosome structural change which lead to bridges at division or genetic unbalance after division".

It is evident that the author has devoted great care and effort to the preparation of this book. The bibliography is especially valuable. Three minor printing errors have been detected.

It is to be noted that although this book was published in 1946, the preface is dated July 1944. It was not possible for the author to include references to more recent work such as the papers of C. D. Darlington and L. F. La Cour (*J. Genet.*, 46, 180; 1945), G. Hevesy (*Rev. Mod. Phys.*, 17, 102; 1945) and C. Auerbach and J. M. Robson (*Nature*, **157**, 302; 1946). It is unfortunate that official secrecy prevented the author from commenting on the production of chromosome breakage by chemical agents. These inevitable omissions do not appreciably detract from the great value of this book, but suggest that progress will be made in the direction of cytochemistry.

J. S. MITCHELL

SCIENCE OF MANAGEMENT

An Approach to Management

By G. E. Milward. Pp. ix+82. (London: Macdonald and Evans, 1946.) 8*s*. 6*d*. net.

AN article on report writing in a recent issue of *Chemical and Metallurgical Engineering* tabulated a series of questions regarding the readers for whom the report is intended and the purpose in writing the report which it was suggested a writer would do well to consider before putting pen to paper. Looking at the growing mass of books on management in all its aspects, it is difficult to believe that some of the authors have honestly faced the questions listed in that article or that, if they have done so, would dare to publish the honest answers. For the most part, however, British publications in this field represent genuine contributions to the science or art of management and are less open to that charge of pot-boiling.

Mr. Milward's book is in that tradition, and he shows something of that skill in exposition which characterizes the writings of L. R. Urwick or M. P. Follett. He is clear as to the readers for whom it is intended. those experienced in management who are still young enough to think in terms of the future, and young men who will themselves become managers. His justification for publication may be found in the comment of the Percy Report on the poor quality of the present literature of management in Great Britain and the absence of the intellectual quality of a sound mental discipline.

That remark is even more apposite of the American literature, which represents by far the great part of that available, and in presenting these notes, which he has used and developed in teaching the principles of management, Mr. Milward has largely succeeded in avoiding the platitudes and excrescences which have marred so many books on management and administration. It can be fairly claimed that in this short volume he has set the subject in a clear and true perspective in its relation to industrial and social efficiency, and indicated an approach to further study which gives full weight to the many factors which have now to be weighed. It represents a modest contribution towards that higher standard of literature on management which developments like the British Institute of Management and the Administrative Staff College are bound to stimulate, not to mention some frank comments in the Working Party reports.

Mr. Milward deals with his subject from two points of view: the management of people and the management of work. The first aspect, the human factor, which is the more prominent at the present time, he discusses in less than thirty pages, and the essential factors and principles are lucidly presented. Naturally, there are some omissions—the most important, perhaps, from the point of view of the further study the book is intended to assist being the absence of any reference to Dubreuil's work on the autonomous group. Compression has also spoilt the sequence in his third chapter. The transition of thought from the consideration of the place and functions of committees to the technique of interviewing is too abrupt and somewhat forced. For all that, Mr. Milward has packed into these pages a remarkable amount of sound common sense in a most readable form.

The four chapters which make up the second part of the book are not quite in the same high class of expression; yet they give a balanced but comprehensive survey of the principles and operations involved in the management of work, the preparation of work, the process of command and of the need for training. Without becoming trite the author emphasizes the right points in such matters as the line of authority, the planning of work and policy, the division of work, the choice of organisation and the co-ordination of activities and the issue of instructions, and it would not be easy to find another volume of eighty pages which covers the ground so comprehensively, soundly and suggestively. It is for that very reason to be regretted that Mr. Milward's bibliography is so restricted. While he has rightly omitted the great mass of second- and third-rate material with which the literature of management is cluttered, he has left out, too, some of the more important books as well as some of what might be termed the source material, such as reports of the Select Committee on National Expenditure or the report of the President's Committee on Administrative Management, which to the student are particularly valuable for the criticisms and analysis of administrative practice which they contain. The omission is the more serious as his book will assuredly be criticized in some quarters because it does not give more guidance on practical aspects of management, and also because any contribution towards the establishment of a mental discipline should seek to facilitate the wider reading which assists the formation of independent judgment.

R Brightman

THE ELECTRIC SPARK

The Mechanism of the Electric Spark

By Prof. Leonard B. Loeb and John M Meek Pp. xiii+188. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1941.) 3.50 dollars.

SPARKING processes control the development of the lightning discharge, the minute gaseous discharges in solid dielectrics which can cause deterioration and ultimate failure, the breakdown of measuring and protective gaps, and the operation of many types of switchgear. The subject-matter of the book under notice is therefore of wide interest. The book is divided into three chapters, in the first of which the classical theory of Townsend is critically examined.

The common starting-point for all theories of the spark discharge is the formation of the electron avalanche. An electron in a gas in travelling a distance x in an electric field X creates $e^{\alpha x}$ new electrons by collision processes; α, the ionization coefficient for electrons, is the number of electrons created in 1 cm of travel and is a function of X. Before the spark can be established an additional supply of electrons is required in the volume swept by this so-called avalanche. Townsend assumed that the positive ions created during avalanche development produced new electrons by collision processes. When it was established that an inadequate supply of electrons was provided by this process, one involving the release of electrons from the cathode by positive ion bombardment was postulated. Theories in which secondary processes for the creation of electrons depended on movement of positive ions remained generally acceptable until it was shown experimentally that at atmospheric pressure the spark could be established in 10^{-7} sec.; in this time there could be inappreciable movement of positive ions. Other secondary mechanisms dependent only on electron and photon movements would account for the very short interval between the formation of the avalanche and the establishment of the spark. A study of such mechanisms led the authors to formulate the streamer theory of the electric spark, to an exposition of which the second chapter is directed.

In addition to the intense ionization in the volume swept by the avalanche, large numbers of photons are produced which are absorbed in the gas and at the cathode, leading to considerable photo-ionization. The applied electric field near the anode is reinforced by the space charge field left when the original avalanche enters the anode. The photo-electrons in the enhanced field produce new avalanches, which with the original positive space charge form a 'conducting plasma' at the anode while the positive space charge left behind gives rise to a new region of increased field nearer the cathode. And so the process goes on until the 'conducting plasma' or streamer bridges the gap between the electrodes. If circuit conditions permit, there is a sudden rush of electrons up the channel and the spark is established. The velocities of the different processes are of the order 2×10^7 cm./sec. for the avalanche, 10^8 cm /sec for the streamer, and 10^9–10^{10} cm./sec. for the intense wave of ionization.

The space charge field near the anode is calculated by assuming that the ions there are located in a sphere of radius r equal to the radius of the avalanche at the anode, and that the ionic density in the sphere is the same as that at the anode. By means of certain approximations, experimentally derived constants, and theoretical considerations the space charge field is expressed in terms of α, x the length of the avalanche and p the gas pressure. To complete the quantitative formulation of the theory, a relation is required between the space charge and the applied field. Meek, the junior author, supplied this by postulating that for streamer formation they should be equal. (Later, to secure better agreement between experimental and calculated values, he assumed that the ratio of space charge field to applied field is 0·1.) The quantitative theory has been used with considerable success to calculate the sparkover voltage of different electrode arrangements in air, and the third and final chapter of the book gives details of such calculations.

For low-pressure regions, and gaps greater than about 15 cm. at atmospheric pressure, calculations were not supported by experimental evidence. It was concluded that in spite of the adequate value of the space charge field there was a factor inhibiting streamer formation, namely, inadequate photon production near the head of the avalanche. In the low-pressure region sufficient photon activity could not be obtained and consequently a streamer mechanism for the spark discharge could not be invoked; in the large gap region it was necessary to increase the stress above that calculated, to provide the required photo-excitation. In this case, the avalanche-streamer mechanism is slightly modified from that in which the avalanche proceeds from cathode to anode and the streamer from anode to cathode. The streamer may start from the anode at the head of an avalanche which has originated in the mid-gap region, and then proceed to the cathode. Alternatively, it may begin at the head of an avalanche in the mid-gap region and proceed towards the cathode; meanwhile the avalanche moves on towards the anode a short distance when a new streamer forms at its head, and moves towards the cathode to join the first. The process is continued until the gap is bridged by the streamer. The authors describe this process as "avalanche-retrograde-streamer advance" and have modified the quantitative theory to cover it

The streamer theory succeeds where the Townsend theory fails in explaining how the spark can be established in times of the order of 10^{-7} sec., and it accounts satisfactorily for many of the characteristics of short sparks. It is inadequate to deal completely with long spark discharges, for example, the stepped leader of lightning. It is difficult to assess the value of the quantitative aspect of the theory. Good agreement between experimental and calculated values of sparkover voltage is obtained for a limited range of values of $p\delta$ (δ gap length), and the range is extended by modifying the theory; the authors themselves emphasize the danger of assessing the correctness of sparkover theories on the basis of such agreements. The assumptions underlying the quantitative theory are clearly stated, but the expedients necessary to make the development tractable, and the arbitrary or empirical choice for the value of k

(ratio space charge field to applied field) are intellectually unsatisfying. The whole basis of the quantitative theory has been subjected to severe criticism (Zeleny, *J. App. Phys*, 13, 444).

The book generally presents a complex argument clearly, but exception might be taken to the use of the terms 'retrograde streamer', 'positive streamer' and 'negative streamer', since all the streamers described contain negative and positive particles and the direction of growth is always towards the cathode. This contribution marks a step forward in our knowledge of sparking mechanisms; but the end of the story is not yet in sight. R. DAVIS

TRADE MARKS IN INDIA

The Law and Practice under the Trade Marks Act, 1940

(As amended by the Trade Marks (Amendment) Acts of 1941 and 1943); with a Full Collection of Statutes, Rules, Forms and Precedents, and a Guide to the Classification of Goods under the Trade Marks Act, 1940. By Dr. S. Venkateswaran. Pp. lxxvii+1,128. (Calcutta: Eastern Law House, Ltd., 1945.) 30 rupees.

AT a time when India is about to become self-governing and replace outside influences by Indian, it is not uninteresting to note that only so recently as 1940 India adopted, almost entirely, the English law relating to the registration of trade marks. It is, however, somewhat startling to realize that a country with such strong commercial interests as India should have managed without registered trade marks until that date, and that traders were obliged to rely on cumbersome and expensive passing-off actions to protect their name and goods. Apparently until after the First World War attempts at legislation in that direction met with only lukewarm encouragement, and it was not until the 'twenties that the matter received popular support from the Indian commercial public.

This delay has not been wholly unfavourable to India, as they have been able to avoid the trials and errors of the earlier English trade mark Acts and have adopted English trade mark law as it stands to-day. The Indian Trade Mark Act, 1940 (as amended by the Acts of 1941 and 1943), is based on the Trade Marks Act, 1938, and where it departs from English law is (with one or two exceptions) mainly for administrative purposes; and in fundamental legal principles it follows the English statute, adopting the innovations, such as registered users, defensive registration, assignment with or without the goodwill of a business, which were introduced by the Trade Marks Act of 1938.

The author of the present volume, Dr. S. Venkateswaran, has compiled what may well become a standard work on the subject, if the law remains substantially unaltered, and it is scarcely likely that registration of trade marks will be renounced so long as individual trading is protected. The form of the text consists in stating the sections of the Act, and following each section with exhaustive notes on the English case law dealing with the particular principle, and giving some history of the corresponding section of the English Act. These notes are possibly too detailed and elaborate, and a person unacquainted with the subject may find it difficult to use this book as a reference book; but this is a minor fault, as the arrangement and indexing has been done with great care and, on the whole, admirable clarity. Notwithstanding that Dr. Venkateswaran says in the preface that the English cases cited "are of value only insofar as they lay down the principles of law and give guidance on the construction of the section", the quotations from English case law are encyclopædic and as up-to-date as is possible in a book which must take some time in going through the press, and are an exceedingly valuable guide to the judicial interpretation of English trade mark law. It is to be hoped, however, that if in future editions notes of Indian judicial decisions are given in equal length, the author will not forbear to cut or condense some of his earlier notes, as this book (1,128 pages in all) is as large as is convenient for any text-book.

The book covers the whole of the Trade Marks Act and includes the substantive law and procedure relating to the registration of trade marks, the essential requirements for the registration of a trade mark, rectification and correction of the register, the duration and assignment of trade marks, the action for infringement and specialized types of registration, such as certification marks, for example.

The arrangement of the book has been well done, both as to text, appendixes and index; the appendixes, besides containing the Act and Rules, tables comparing the Indian Act with the English Acts of 1905 and 1938, have much useful information relating to pleadings and forms and orders used in English trade mark cases. IRENE G. R. MOSES

TRUTH AND ITS EXPRESSION

In Search of Truth

By Dr. Abel J. Jones. (Discussion Books, No. 79.) Pp. 208. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1945.) 3*s*. 6*d*. net.

DR. ABEL J. JONES'S volume rightly appears in a series of "Discussion Books". He never lays down the law, but offers an abundance—perhaps a superabundance—of material designed to set the reader thinking. His aim has been to give an account of the way in which men of science, historians, philosophers, artists, poets, moral and religious teachers and others have searched for truth and tried to express it. He admits that some readers may find the treatment too brief, but hopes they may find the book of interest as a conspectus of the whole subject. Indeed the reviewer, after an attentive perusal, has come to regard the book as a handy directory, written by a person of wide sympathies and encyclopædic reading, and he proposes to give it a place among his reference books. Here he can only offer a few comments. The chapter on "The Liars in their Lairs" is both diverting and incisive. The author quotes to good effect the philosopher who said, "if you ask me what time is I cannot tell you, but I know what it is if you do not ask me". It will be news to many that Mussolini founded his morality on the pragmatism of William James. The sections on our habits of labelling and on "the bondage of consistency" are much to the point. The one chapter which the reviewer finds inadequate is that on historical truth, where no account is taken of the positions held by G. M. Trevelyan, J. B. Bury, J. Buchan, and others.

DEVASTATION*

By Sir JOHN L. MYRES, O.B.E., F.B.A.

Physical Devastation

IN a recent essay I examined the mode of life known as *nomadism*[1], where a human community is maintained by the produce of domesticated animals sustaining themselves in grassland without injury to its plant-covering: a mode of life, indeed, in which defacement of the plant-covering by ploughing or digging is the worst of economic offences. In another[2], I presented the fundamental and elementary culture of the Mediterranean, based on a combination of cereal agriculture and tree-fruit crops, with subsidiary pasturage, hunting, and fishing, as an approximately stable regime, which presumes a cycle of soil-restoration, by fallow-grazing, and the rejuvenation of forests exploited for fuel or timber. There are, however, modes of subsistence for human communities which presume the destruction, or at all events the removal, of some irreplaceable part of the natural resources of their habitat; which exploit, that is, a wasting asset, or, in other words, live on their regional capital. What follows is an attempt to compare, classify, and interpret these forms of what collectively will be described as *devastation*, and to illustrate their economic and social consequences.

The most incisive study of "Destructive Exploitation" hitherto is that of Jean Brunhes, in his "Human Geography" (1910), but there is something still to be said. Mineral devastation he regarded as a local and temporary derangement. Forest devastation on a great scale was only beginning; he noted, however, the destruction of seals, whales, and bison, and the practical difficulty of conserving fisheries. He emphasized the slave-trade as a gross form of devastation, and noted the reaction, already perceptible in 1910, towards a 'planned economy'. On the general issue, he regarded it as "the part assigned to living beings; to retard the degradation of energy in the world. . . ." (p. 350). The result of evolution (he held) "is definitely expressed by an increase in the energy utilized. But utilized energy must not be confounded with available energy."

In its simplest, most diagrammatic form, devastation removes something irreplaceable, and is consequently limited to chemical and physical destruction; all biological destruction being replaceable when natural processes are restored to normal activity. Game is conserved by a close season, deforestation by afforestation, without positive remedial interference of man. Minerals, on the other hand, whatever their origin, are not replaced in their lodes within any period that can be foreseen. The miner has no direct interest in remedying his spoliation.

With foresight, effort, and expense, disfigurement may be minimized. But more commonly the waste product of the mines is allowed to accumulate unutilized. This indifference to waste affects also the miner's estimate of his capital-expenditure in buildings and means of access; all that is not transferable to another scene of devastation is written off and left derelict; and this applies also to the labour-supply. The miner, like his shanty, is written off when he is paid off.

This prospect is, however, not always foreseen by the miners themselves, especially when the supply of mineral has lasted long, and the occupation has become hereditary. In the tin mines of Cornwall, the collieries in South Wales, and elsewhere, a tragic aspect of devastation has been the inability of the mining population to realize what was unavoidable, even when it was imminent. If there were sinking-funds at all, they were for the replacement of capital, not of mineral. Where exhaustion has been foreseen, on the other hand, the miner's link with the locality has been weak, and his economy feckless.

Where a mining community has matured, on the other hand, its needs have brought into being supplementary activities—pastoral, agricultural, and industrial—which are parasitic on the mining population, and superfluous if mining comes to an end, unless like Swansea it can replace local minerals by imported, or maintain itself as an administrative or commercial centre, which would seem to be the prospect for Johannesburg The outlook is still more grave on a larger scale, as Brunhes has illustrated in his analysis of the coal-mining culture of Western Europe.

Most mining is subterranean, and for reasons of safety must be carried on in narrow galleries and stalls, by artificial light, and in personal discomfort and risk. The effects on temper and outlook are well marked. Much that vitally concerns the miner must go on literally 'behind his back', and the strain on honesty and confidence is severer than in most kinds of organised work. Even when hours worked 'at the face' are reasonable, distances may be great, and they increase; the gross hours of absence from home become excessive; and night-shifts are habitual. The time available for any kind of study, discussion, or social intercourse is therefore severely limited, and the miner's outlook tends to be restricted. The physical strength and hardihood of a mining population may cause it to be feared and avoided, sometimes with reason. The mental reactions to habitual violent exertion have not been fully investigated, but should not be left out of account; and when a community of similarly qualified persons is inbred for long, it may be expected that congenial strains will become dominant.

In another respect, too, mining is a precarious enterprise. Some primitive mining is seasonal, by reason of altitude or water-supply. In Turkey, and other agricultural countries, men go to the mines in the slack season between seed-time and harvest; the mining-camp, like the fisherman's boat, is not their home. But maintenance must be provided for them at their work. Even in cultivable country, the concentration of many non-agricultural workers deranges the food supply.

Like the food supply, other natural resources are deranged by mining operations, especially the timber supply for props and for fuel. The ancient name of Thucydides' estate in Thrace—*Skapte Hyle*, the 'excavated wood'—reads like a glimpse of Montana, with the shafts and mine-dumps among the draggled pines.

The miner's dependence on his own strength and skill, and his precarious tenure of his workplace, lead to severe elimination of the unfit, and an austerely competitive self-regarding outlook among those best qualified for a very abnormal mode of life. Among all backwoodsmen, the miner has the highest vogue in the literature of personal adventure, and, corresponding with his physical difficulties and uncertainties, the fabulous reward of a 'lucky strike' is proverbial. Personal friendship with your 'pal', less

* Substance of a lecture before the Royal Anthropological Institute delivered on September 24. (London: Roy. Anthrop. Inst. 2s. 6d.)

uniform loyalty to your 'boss', only yield gradually to wider ties within gangs and unions, less affected by individual windfalls.

Where a mineral deposit has been worked for long, and on a large scale, and a permanent self-supplying community of professional miners has come into being, the special skill of its members becomes itself a valuable asset. In the Turkish province of Trabzon, at Gumush-Khané, 'the place of silver', not only is the ancient silver mine worked by a close-knit community of hereditary miners, who have their own farms and pastures, as well as their mineral wealth, but also the men of Gumush-Khané are in wide demand as skilled miners for all kinds of minerals, and find work in all parts of Anatolia. The Cornish miners are another instance.

In such circumstances, the mine, and related deposits of ore, are in communal ownership, like forests, pastures and streams. But where for any historical reason there is personal rule, and universally where there has been conquest, the *de facto* owner of territory is *de jure* owner of its natural resources, including its minerals Historically this custom has led to abuses, as when a chief responsible to his community for customary obligations and outgoings has been induced to surrender his economic interest in his minerals for inadequate compensation, and public disapproval falls both on him and on the foreign adventurer who beguiled him.

All mining begins from the surface, or on surface indications recognizable by a prospector; but most mining requires capital expenditure on preparatory work, and usually, also, throughout the enterprise. This capitalist interest is all the more keen, because whatever the actual expenditure on development may be—and it is often great—it is at all events less than it would have been had there been any compulsion to make good all damage to the minefield, or (as in agriculture) to leave the land 'in good heart' for another crop. It is only in very exceptional circumstances that such a condition is imposed, and it is in any event difficult to enforce because the obligation does not mature until the mine has ceased to be remunerative, and then the mine-worker himself has no assets but idle mining-plant on which the landlord can distrain.

It is only recently that attention has been directed to this aspect of mineral exploitation, by actual shortages in the world supply of mineral products, especially the 'non-ferrous' metals; by the consequent scramble among financiers, and among States with positive financial policies, for the remaining resources of these kinds; and by the recent enunciation of a new principle of equitable participation in whatever mineral resources may remain unworked after the restoration of a rule of law in the world.

Theoretically, the exhaustion of the world supply of a particular mineral product may be compensated —or at least postponed—by 'salvage'. The alternative is a non-mineral substitute, such as the new 'plastic' substances, even for many metallic objects. These, however, are only palliatives and subterfuges. They do not affect the fact that all mining enterprises permanently and irretrievably reduce the economic resources available to mankind on this earth, and that, as at present conducted, they have economic and social effects which are as difficult to control as the processes of exploitation and devastation are to justify, except on the most individualistic and self-centred hypothesis of 'Man's place in Nature'.

Man is the only living being which has the will to transform his habitat, and the skill and means to do so. The engineering work of ants, moles and beavers leaves no permanent disfigurement Man is also the only being responsible for the effects of his changes, for he alone has the reason and imagination to foresee them, though often he does not. Sometimes his responsibility is brought home to him by physical disaster, more or less abrupt, as in the effects of deforestation, over-cropping or over-grazing. More often, hitherto, the disastrous process has been slow; but on the historical time-scale some such effects of devastation are obvious, and others are imminent, if not measurable.

Biological Devastation

Before going further in search of a principle, economic or moral (and in *moral* we may include for this purpose *political*), it will help to clarify the whole matter, if we inquire what other forms of human exploitation of natural resources besides the search for minerals come within the same general category of devastation.

Quarrying, as a devastation subsidiary to agriculture or to industry, stands to independent mining as sedentary herding to nomadism. Salt mining is a special problem, because in brine-extraction the mineral is removed without regard for the stability of the overload, and the surface may be impaired, as at Nantwich, by subsidence. But in essentials these enterprises also (like mining) exploit wasting assets, and replacement is impossible.

Wood-cutting is a widespread mode of life, with its own simple economy. It emerges from mere forest-life as soon as the forester cuts trees not for his own needs, but for exchange with the products of non-forest communities, as in northern and southwestern Anatolia. Here, too, much forestry is seasonal work, and fills intervals in the cultivator's routine. In many of these enterprises the aggression is on a single kind of tree or shrub. The forest complex is modified but not utterly deranged, and no perceptible damage is done to the humus or subsoil. What applies to this partial, specific, or selective destruction of trees applies also instructively to total deforestation by fire, however caused: for there is a cycle of recovery.

Quite different is deliberate and indiscriminate felling—whether accompanied by incendiarism or not —with the object of replacing forest by pasture or arable. If the pastoral cycle be arrested at this point, the herdsman's object is attained, probably without sacrificing eventual re-afforestation, should the flocks be withdrawn, provided only that natural nurseries of the appropriate forest trees have survived in sheltered places, from which their seeds may spread.

But there is also the risk of over-grazing, especially where the natural vegetation consists rather of shrubs and bushes than of turf, and the flocks—especially the omnivorous goats—mow off the new growth so close to the ground that the plants are stunted and perish, and rain denudes the humus and erodes the subsoil.

Similarly, trouble is only beginning for the cultivator when he strips the land of its forest covering, and continually breaks up its surface by ploughing. In many regions converted from forest or grassland to agriculture, the initial burning of the natural vegetation—which started the new cycle, unawares, with a top-dressing of wood ashes—falsified estimates of its productivity; and the large scale of prairie farming made the small holder's remedy of fallow-grazing impracticable. Nothing, in fact, was returned to the soil, for the cereal crops were cut low so as to profit from the full length of the straw for winter fodder, thatching, and home-industries, if not for export. Even within the short historical span of prairie farming, therefore, much arable land has been devastated by over-cropping, and 'dust-bowl' areas have been formed, for which the remedy is not yet found.

Fortunately, where the devastation is not yet complete, it is possible to repair some, if not all, the damage, by spreading fertilizers, themselves usually quarry-products, and by restricting or rotating the crops; but the cumulative effects of more artificial farming are not yet fully explored.

In general, what has been learned by disastrous experience in a few extreme instances is that it is as possible to devastate land inconsiderately used in human economy as to exhaust a mine.

We may now turn to animal devastation. It is sufficient to refer to the recent instances of the American bison, the fur-seal, and the northern whale, to illustrate the rapid and unforeseen results of excessive hunting and fishing, and the difficulty of restoring a disturbed economy of this kind. The balance of biological factors is far too delicate and intricate to be regulated without greater knowledge and insight than man at present has. The whole problem is complicated by the disappearance, already noted, of large areas of woodland refuge for the larger game-animals. If man had known enough, and cared enough, about what he was doing, these irretrievable defacements of Nature would not have occurred.

It is convenient to summarize, at this point, the economic characteristics of devastatory communities. In the first place, they seek a wilderness, contribute nothing directly to their own maintenance in it, and have to be supplied with maintenance from elsewhere, so long as there is a demand elsewhere for the irreplaceable commodities they are there producing. Secondly, they tend to make a wilderness, by displacing and squandering the waste products of their quest, and usually without regard to reparation. Thirdly, the exceptional and marginal conditions of their occupation disorganise the normal social life of the devastators themselves; and, fourthly, they tend to mitigate these austerities by imposing the more arduous efforts on indigenous labourers. That they have been unaware of the further devastation thus effected is a measure of their own alienation from the outlook and practices of the communities from which they themselves originated.

Once again, as so often in human affairs, we find ourselves confronted with ancient Greek experience, and the practical wisdom embodied in the 'Two Commandments' of the Delphic Oracle: *Know thyself*, and *Nothing in excess*. To dominate Nature, man must stoop to conquer, by conformity with Nature's processes and conditions. He must 'look to the end', take long views and long resolutions, omitting no relevant circumstance from his calculations: the Greek word for *truth* means simply *not forgetting* any relevant fact. He must know his 'place in Nature', and for this he must also 'know himself'; estimate his needs and desires, and also his abilities and temptations to do this or that 'in excess'. The sole criterion of 'excess' between man and man is, once again, the golden rule: "to do unto others as we would they should do unto us"; or again, in Greek phrase, "to behave as similars and equals", limiting our own freedom lest it infringe the freedom of our neighbour. Here is the sole and sure basis for man's use of Nature's resources, and for his own qualifications and ability to use them, the sole criterion of *value* and *rightness* between human cultures and modes of life.

Ethnology has gone on overlong without realizing that *behaviour* is a principal character of every tribe and people whom it studies, intimately related to breed and habitat and mode of maintenance and propagation; distinct from them all in its relation to man's self-conscious outlook on himself, and his world, but not, for that reason at all events, beyond the scope of ethnological study.

The Devastation of Man

Of all the resources of Nature at the disposal of man's initiative and ingenuity, far the most abundantly rewarded is the energy and skill of other men Aristotle's tentative but not final description of a slave is 'a tool in place of tools', an indefinite extension of a man's own capacity for action at a distance, or for acting in different ways at the same time. He illustrates his point by imagining an automatic loom or musical instrument—both very nearly attainable in our time What he does not, however, at that stage in his examination of slavery attempt to prove, is that there actually *are* any such human beings as those he imagines for his argument.

It was known, moreover, even in slave-owning antiquity, that a slave was more than that. A slave, however docile and competent, *wore out*, as a loom or a lyre did not, and however well groomed, lodged, and fed, tended to wear out sooner than his master; also that he tended to wear out less soon, if he had a reasonable prospect of acquiring personal freedom while he still had the ability to make use of it. It was equally notorious, in antiquity, that the supply of slaves was not easily maintained: they came from farther and farther afield, and from stocks and breeds less amenable to servitude, and the slave trade was carried on with a degree of hardship and irresponsibility which classed the slave-raider with the pirate and bandit. In modern times, too, it was the atrocities, as much as the wrongfulness of the slave-trade, that roused public opinion and suppressed the traffic. Slave-raiders were exhausting a wasting asset, the chief export of tropical Africa.

There was, however, a principle at stake, a question of justice between man and man, the answer to which is inevitable, when the Golden Rule is applied: "Do unto others as you would they should do unto you". Philosophically it results, like the Golden Rule itself, from the fact that each individual man, whatever his place in Nature, is an end in himself, not a means to fulfil the end of any other man. Nothing precludes him from contributing what he can, and all that he can, to fulfil the ends of another, whether individual friend, or fellow-member of a society of men; but unless it is also all that he *will*, his *own* contribution, voluntary and deliberate, it is a diminution of his human freedom and a devastation of his personality. Like the utility of a mine or an oil-well, the potential, the literal *man-power* of each individual is a wasting asset. Like other such utilities, it can be economized, but not amplified, either by the man himself or by any other person. The abuse or misuse of another man's potential appears to fall into the same general category of devastation as the abuse or misuse of any other of Nature's utilities. The world will be a poorer place when he is no more: and in the infinite variety of human personality and endowment, even the physical replacement of one generation of men by another only *replaces*; it does not restore

This is what differentiates social or human individuality from biological—the separate existence of an animal or a plant; and it refutes analogy between the use or misuse of men, and of domestic animals.

Ends and Means: The Conditions of Sacrifice or Total Surrender

We have now reached a point in our argument at which we may ask the general question, in terms applicable alike to a gold mine or coal mine, or to members of a human society: "In what circumstances, and for what objects, is the devastation of any of the resources of Nature, or of humanity, compensated by its consequences and results?" The question may be approached from two different points of view; but both, like the question itself, introduce the new notion of *value*, even if only in the minimal aspect—as stated here—of equivalence or compensation, of 'handing on undiminished' the resources of Nature which are at man's disposal. Brunhes demanded more: "to retard the degradation of energy" in a world which must go cold and dead some day.

If we had infinite knowledge of the course of Nature and of man's destiny, we could observe directly, or calculate, the cosmic result of any displacement—the removal of metallic ore, or the sending of a human messenger—and the cumulative effects of such acts on the planet or on humanity. If our estimate of values were commensurate with our knowledge of events, we could approve or condemn such an act accordingly. As we contemplate in imagination the withdrawal of this or that aspect of reality from our knowledge, we find our judgments in either category becoming more hypothetical. For many practical purposes, nevertheless, decisions are commonly taken which presume that something which we regard as 'benefit' accrues from obvious and immediate devastation, in the sense defined.

Mankind, however, is not thus replaceable, and it is that uniqueness of the human individuals that distinguishes them from individual animals or plants, which are members of a natural species and replaceable by others of their kind. It is indeed because they are thus replaceable that man's exploitation of flocks and crops is an essential element in this 'place in Nature'. No one, on the other hand, can replace a man. Each of them only lives once, making such use of his life as he can, and responsible to his own conscience—if to no one else—for his use of it. Each is also responsible, under the Golden Rule, for infringement of the liberty of every other so to live, as he does; and this liberty—his own and his neighbour's freedom alike—is a wasting asset; short of some transmigration or rejuvenation of souls, it cannot recur.

Whether in any circumstances—and if so, in what?—a man is required to limit or to surrender this freedom is, once again, for the Golden Rule to determine. It is sufficient for the present purpose to have formulated the question in terms which make it comparable with the question about other 'wasting assets', such as metallic ores, with which this inquiry began. But in the light of the whole argument, as it has developed, are we any nearer to a formula and criterion applicable to this whole group of human enterprises? I venture to suggest that we are.

It is a significant accident that among Athenian activities mining enterprises held a high place, and that many public as well as private achievements during the 'great age' of Athens were made possible by the public revenue from Attic silver. It was at all events the hypothesis on which Athenian policy as well as finance rested that this form, among others, of public wealth was fully accounted for, if it was spent—as Pericles himself claimed on a crucial occasion—for a necessary object; and in the last resort it was the citizens of Athens themselves, by direct vote, or by their selection and approval of their administrators, who decided what this was.

With fuller knowledge than theirs, and wider experience, sometimes we can approve their choice, sometimes not. Cumulatively, and, in the end, economically speaking, they failed to 'transmit undiminished' what their predecessors had held, including whatever it was for which they had won and expended their material 'wasting assets', their blood as well as their treasure. Is this, however, the whole of the account? Were there not, historically speaking—and 'history' is our judgment of other values, besides economic—other achievements of Athens, by which mankind remains enriched and ennobled, beyond question of loss or devastation? The argument is passing here out of the economic into another aspect of ethnology, and it will be observed that it does so precisely in respect of an economic commodity, a wasting asset, the mineral resources of Attica; whatever other factors, not economic, went to the invention of a justifiable use for that commodity, in the maintenance and enhancement of the mode of life, the culture, the well-being of the Athenian people.

Evidently there is to be made, once again, the distinction between wasting assets which are extinguished utterly and irreplaceably by destruction or removal of a natural commodity (such as an ore), and those which are indeed destroyed sooner or later by degradation or devastation, but where the process may be checked or even reversed by appropriate remedies. In the first alternative, there is indeed no remedy. All that can be done is to impose such restrictions as research and foresight may prescribe, so that the natural supply may meet necessary demands for as long as possible; and, in the respite so gained, to apply human ingenuity to discover or invent a substitute, in addition to obliterating the damage incidental to extraction.

In the second alternative, where devastation can be prevented by foresight and research, the 'more excellent way' is deliberate and voluntary reconstruction by the legal owner of the land himself. Every civilized farmer or forester, hunter or fisherman, recognizes this, and brings his own judgment, and that of public opinion, to bear on reckless or malicious owners. In civilized countries, uniformity of self-repression is enforced by public rules and penalties. This is indeed the fundamental attribute of civilized people, that they are mutually considerate, taking each other's situation or predicament into account, conforming to the Golden Rule by that longer view which reckons consequences as well as immediate advantage. It is, on the other hand, characteristic of barbarism—which, fundamentally, is inability to make oneself understood, or to understand what others mean—that it grasps at momentary advantage and opportunity, without regard to consequences or the convenience of other people.

Within any community it is the same: there are *civil* persons, in the primary sense of that ancient word, and there are uncivil, for whom the Roman correlative was *hostis* (hostile, 'not of our sort'). Many simple societies are fully aware of the distinction; of where the boundary lies, and what the procedure is when it is transgressed.

More commonly, however, 'evil is wrought for want of thought', and especially for want of knowledge and experience; and there are sufficient instances of revolutionary changes resulting immediately from a fresh apprehension of the facts, and of public self-control in respect of the devastated asset of man-power. The thing can be done, if people want to do it. Where there's a will, there's a way.

It is indeed an obvious remedy, where devastation is unavoidable and irremediable, to seek for a substitute, the source of which is replaceable in the ordinary course of Nature. Most significant of all, the long vogue of slavery—the abuse of the most irreplaceable of 'wasting assets', human energy—was ended less by a moral revolution in regard to the 'natural rights' of man, than by the invention of sources of mechanical power, which made man-power uneconomic, as well as unobtainable, on the scale needed by mechanical industries.

It has been the constant claim of ethnologists that their method of functional analysis and of comparative study of modes of life not superficially similar, aids in understanding the doings of primitive and cultured men alike. If it be true, as Brunhes claimed, that the part assigned to living beings is to 'retard the degradation of energy' in the world, it is a paradox that the most disastrous devastations have resulted from the thoughtless activities of peoples whose cultures, however unbalanced, have achieved in some respects notable advancement. It is, however, some gain if the peoples themselves whose activities have been disastrous, because thoughtless, are brought, either by example, or by the first warnings of necessity, to review their own past and present doings, and take longer views into the future, and wider views of their 'place in Nature' and in a Society of Nations. It is some gain also if the practices of peoples, primitive and advanced alike, can be submitted to a test which is at the same time objective and a standard of value; applicable alike to economic commodities, and to the use and abuse of what must always be man's ultimate source of energy, the co-operation of his fellow-men.

[1] "Nomadism", *J. Roy. Anthrop Inst.*, 71, 19 (1944).
[2] "Mediterranean Culture" (C U.P., 1944).

THE RUMEN PROCESS AS A FUNCTIONAL FIELD: AN ATTEMPT AT SYNTHESIS

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THE changes taking place in the rumen may be envisaged as a form of process organised with reference to the utilization of microbial products. Such an organisation in which a complex system of factors, internal and external[1], converges upon the attainment of a final state may be termed a functional field[2,3]. Thus the efficiency of the process will devolve upon the intensity of the field established and will be exemplified in the degree of integration achieved between the metabolism of the animal and the activities of an indigenous microbial population. Correlatively, the actual organisation of the gut will in part define in advance the working capacities of the system. A comparison of these features in ruminant and non-ruminant Herbivora, therefore, is essential to an understanding of the rumen process.

Now it is axiomatic that the utilization of microbial products presupposes the maintenance of a microbial population of high density. This requirement is met by the development of large diverticula—the rumen and cæcum—which stand in a compensatory relation in ruminants and non-ruminants and in which extensive proliferation can occur. Again, the total output of microbial products will be determined, severally, by the volume of the organ, the period of retention and the extent to which, over this period, optimal conditions prevail. But a limit is imposed upon mere volume by the position of the organ in the *situs viscerum* and its relation to the overall dimensions of the animal. Again, in the cæcum of non-ruminants a term is set to retention by the risk of impaction[4] and the insistence of peristalsis. In the ruminant, however, these obstacles are surmounted and an increased duration secured by the incorporation of a repetitive mechanism. Here are included exchanges occurring reciprocally between mouth and rumen and rumen and reticulum[5,6]. By the first an adequate trituration of solids is secured, which is perhaps completed in the omasum, while, by the second, fluids are retained in circulation and afford a permanent medium for microbial activity. Disengagement of gases is facilitated by the pulsations of the paunch and buffering promoted by the interaction of the carbon dioxide and gases liberated with the bicarbonates of the saliva[7].

Thus the adoption of the ruminant habit is associated with the superposition of a cyclic upon an initially serial form of process and may be formally represented as the expansion in sphere of influence of a functional field. For the field has temporal as well as spatial dimensions, and in this way its duration as well as its extent is effectively augmented. That we are concerned, moreover, with a regulatory adjustment of internal to external factors is clear from the fact that the rumen is unconditionally, the cæcum only conditionally, associated with the phytophagous habit[8]. Also, whereas the cæcum is well developed *in utero*, the rumen attains completion *post natum* in direct response to the adoption of a vegetable diet[7].

Now in Herbivora, generally, this epoch marks the development of a distinctive microbial association which may include: (*a*) a ciliate, (*b*) a fixed or free iodophile, and (*c*) an aniodophile population[9]. Since the types are constant for a given herbivore, the effects of diet may be represented by reference to its quantitative influence upon the relative densities attained[10]. Thus the maintenance of the field rests upon the dynamic equilibria established between the rates of multiplication of a mixed microbial population. Also, through the establishment of different stability maxima, potentialities for the development of alternative routes of decomposition and synthesis are prefigured the number and diversity of which will determine the regulatory capacities of the system. The release of these potentialities is conditioned by a wide range of factors the influence of which, as estimated by the actual densities of the iodophile and other populations, can in part be elucidated by *in vitro* incubations and counting methods[10].

The natural habitat of this microbial association and the functional bond or link between it and the host animal is the ingested plant material. Cellulosic substrates, for example, are accessible to mammals only through microbial agencies. The relation, none the less, is more complex than at first appears, for the maintenance of the population is a direct consequence of proliferation, so that decomposition is throughout accompanied by synthesis. But for this synthesis a source of nitrogen is essential. The cytoclastic process, therefore, is bound up *ab initio* with the nitrogen requirements of the micro-organisms. Again, the substrate is heterogeneous and will include, as well as cellulose, other carbohydrates. Among these, starch and many sugars are accessible both to the micro-organisms and to their host; thus, with the development of the microbial population, a loss of independently accessible metabolites is potentially incurred by the animal. The micro-organisms responsible for this degradation may be represented as a commensal penumbra to a focus of symbionts The maintenance of the field, then, presupposes that degradation is compensated by regradation through a progressive integration of the peripheral and central components of the system.

The mechanism by which this end is attained may next be considered. Now the respective value of the products of decomposition and synthesis to the host has been widely debated. Thus it is known that, as well as gases, fatty acids are produced. Also it is established that they are taken up by the portal circulation and that, among them, acetic acid can exert a glycogen-sparing action on the heart. From these data a metabolic schema for the utilization of microbial products can be elaborated[11]. That such a schema is, however, complete in itself it is legitimate to doubt. Thus the production of acid and gas may be accompanied by the formation of bacterial starch amounting to nearly 50 per cent dry weight of isolated bacterial substance[12]. But it is certain that the value of starch, taken as glucose, exceeds that of the lower carbon components produced—as, for example, is shown by the inability of the nervous system to metabolize acetic acid[13]. An alternative hypothesis would therefore be[2] that the development of the iodophile population represents a mechanism whereby glycolysis is arrested through removal of the soluble sugars initially present or afterwards liberated from further participation in the reactions taking place. In agreement, we find that (*a*) glucose, cellobiose and maltose are known decomposition products of cellulose and starch; (*b*) glucose disappears almost immediately from the rumen[14]; (*c*) synthesis of bacterial starch from sugars can be demonstrated *in vitro* within a period of 15–30 min.; (*d*) the energy values of starch and cellulose are almost equivalent, which "can only be explained if the end products resulting . . . are the same"[15,16].

But, in addition, we have still to consider the inter-relationships which issue from the conjoint nitrogen requirements of the micro-organisms and their host. These requirements have secured attention largely through the now demonstrated[17] ability of ruminants to utilize non-protein nitrogen in the form of urea. Thus it is known: (1) that the micro-organisms concerned include the self-same iodophile and aniodophile species responsible for the decomposition of starch and sugars[18]; (2) that they are unable directly to utilize protein nitrogen[19]; (3) that urea is utilized as ammonia, through the action of rumen urease[19]; but (4) in the absence of carbohydrate intensive decomposition of protein can also occur[19]. Thus we may suppose that the ability of ruminants to utilize urea is tributary to a process whereby *on normal diets* the nitrogen requirements of the micro-organisms responsible for the decomposition of carbohydrates are met from the products of proteolysis. We can therefore postulate, in addition to cycles of carbohydrate, cycles of protein synthesis and, with the extension in sphere of influence of the field, an ever closer integration of the latter with the former. Also, we must assume that in the ruminant a representative fraction of the available protein is normally assimilated, together with synthesized carbohydrate, as bacterial substance; the amounts being regulated, in accordance with the actual balance of diet components, through the establishment of stability maxima and alternative reaction systems in the manner indicated above Further information regarding these reaction systems and cycles—which must include the interconversions of dietary, bacterial and protozoan protein, through the agency of ciliates—is therefore essential to a detailed understanding of the changes taking place

With increasing intensity of the field the provision of an adequate mechanism of regradation becomes imperative precisely in such measure as the avenues of proteolysis are multiplied. But the efficacy of any such process presupposes the ability of the animal to utilize the substances synthesized. In non-ruminants, however, there is little to indicate that the large bowel can itself digest microbial products. Apart from supplementary mechanisms, therefore, this can be accomplished only by autolysis of the micro-organisms[20]. In ruminants, on the contrary, the situation of the diverticulum is such that the field now embraces in its sphere of influence the entire enzymatic equipment of the true stomach and small bowel. That in this way and through this extension an increased efficiency is secured is apparent, more-over, not only from the increased value of the digestive coefficients for starch and crude fibre, but also from the superior capacities displayed by ruminants in the synthesis and assimilation of vitamins[21]. From this point of view, coprophagy and refection become intelligible as devices through which a vicarious approximation to rumination is achieved. A case in point is the pseudo-rumination encountered in the rabbit, where the soft nocturnal fæces are removed by the animal from its own rectum, devoured and subsequently redigested[22]. Not only, however, are such supplementary mechanisms unable to function uninterruptedly, but also both feeding habits and the overall bodily architecture may prevent their adoption. Functional autonomy, therefore, is only achieved where, as in ruminants, the cyclic process is actually incorporated in the organisation of the digestive tract

This brief reference to the habits of the animal may serve to point a concluding issue. In preceding paragraphs we have considered the organisation of the rumen process primarily as a molar-molecular mechanism. But the endurance of the process as a going concern presupposes, under natural conditions, an active search for and selection of appropriate fodder. Thus the habits of the species are integral to the character of the system. Again, among the indigenous micro-organisms are types incapable of survival outside the digestive tract[5]. The establishment of the field, therefore, presupposes *transmission* as well as *maintenance* of a microbial population—a process that will be determined by the conjoint characteristics of host and micro-organism. The microbial population, for example, may be re-established variously by ingestion of infected fodder, by direct infection from mouth to mouth, or from anus to mouth. The more intimate bodily relationships established between the mother and her young, between the younger and older members of the herd, and between individuals of all ages and the environing pasture, are here in question. For, so regarded, the mechanism of transmission is tributary to an oral-anal instinctual complex, which, organised with reference to the ingestion of food and expulsion of fæces, is conspicuously ingredient in the social and sexual behaviour patterns of the species. But the canalization of these appetites is effected with reference to an environment disclosed to perception. The character of the process in its entirety, therefore, is in part prefigured in the actual modes of awareness of the animal which, as subjective factors, are real agents in the maintenance and perpetuation of the system as a functional field.

For the concepts set out in this article I am in great debt to Prof. F. G. Gregory. The responsibility for their application to this subject is my own.

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PUBLIC HEALTH IN GREAT BRITAIN DURING THE WAR

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THE annual reports of the Ministry of Health were suspended during the period of the War. The Chief Medical Officer, with the assistance of his colleagues, has now issued a comprehensive report covering the period of hostilities between the years 1939–45*. It is an important and inspiring document, and whether as a social, historical or scientific commentary is deserving of close study by all who have an interest in organised human achievement of a positive and constructive kind—an achievement carried through, in this instance, during a period of sustained hazard and unparalleled difficulty. We would differ slightly from its author when he says: "That, after these six years of unprecedented strain alike upon the nation and upon the medical resources of the realm, the state of the public health should be as good as it is to-day is indeed a miracle". A miracle is strictly something due to supernatural agency. The state of the public health can be traced to the advancement of knowledge, to human planning and endeavour and to a number of natural causes which are now better understood than at any time in our previous history.

In the statistical sections we find that the birth-rate, rising after 1941, reached 17·7 in 1944, the highest figure since 1926, the effective reproduction-rate coming within 1 per cent of full replacement standard, although it has fallen since. The infant mortality for the country as a whole fell to its lowest level—45·4 per thousand live births in 1944 as compared with 50·6 in 1939, and 156 in 1896–1900. It also fell significantly in many large cities (from 74 to 58, for example, in Liverpool, and from 66 to 51 in Newcastle-on-Tyne), although Oxford's figures of 23 in 1939 and 25 in 1944 remind us how far we have yet to go elsewhere. Still-births, which again appear to reflect social and nutritional influences, have dropped from 40 per thousand of all births in 1928 to 28 in 1944.

There was a remarkable absence of serious epidemics. Cerebro-spinal fever alone, in the period 1940–41, had a very high incidence. With the new chemotherapies, its case mortality in the past five years was, however, greatly reduced, and it is calculated on the basis of earlier experience that some 15,000 lives were saved by these remedies. Infective jaundice, with a low mortality, gave much trouble in the civilian population and among the troops at home as well as among the armed forces abroad. Movements of population, destruction of water-mains and sewers by bombing and other adverse factors notwithstanding, the typhoidal infections were never a serious menace, and in 1944 were less prevalent than in any pre-war year. In 1944, diphtheria deaths were less than one-third of the pre-war average, largely as a consequence of the Ministry's immunization campaign. Nevertheless, several other countries are far ahead of us in respect of diphtheria control, and it is a sad commentary that during the War more children under fifteen were killed by this preventable disease than by bombs. Although propaganda and public education in health matters have made much headway during the War (largely through the joint activities of the Ministry of Health and the Central Council for Health Education) methods could clearly be much improved.

After an increase in deaths from pulmonary tuberculosis in the period 1939–41, the pre-war downward trend was later resumed and 1944 showed a new low figure. With pasteurization of milk still far from universal, bovine tuberculosis continues to claim among children in each year some 2,000 new cases with 600 deaths—all of which should be regarded as preventable. To offset the increases in tuberculosis, the officers of the Ministry mention in particular the contributions to its early detection of miniature mass radiography and to its treatment of the extension of tuberculosis benefit. On the other hand, they are compelled to regret the existing difficulties in the staffing of enough beds to ensure institutional treatment for all who require it. The venereal diseases, as always in times of war, increased considerably. As against their higher incidence are recorded the very great advances in treatment due to the sulphonamide drugs and penicillin, and the

* On the State of the Public Health during Six Years of War. Report of the Chief Medical Officer of the Ministry of Health, 1939–1945. (London: H.M. Stationery Office, 1946). 5s.

steady extension of contact-tracing and social service and the educational campaign.

Although morbidity studies of various kinds have lately been introduced, including a monthly sampling survey of sickness incidence in the population, it must be admitted that we still know too little of the incidence and trends of the diseases (lethal and non-lethal) outside the notifiable group. Nor can we say how far some of these may have been increased by war-time stress.

Perhaps the greatest and most favourably influential of all the public health undertakings of the war period was the maintenance of a high level of nutrition by rationing and fair distribution of foodstuffs throughout the population, together with the special advantages secured for expectant and nursing mothers and children. To this in large measure may be attributed the resistance to infection and strain of the people of Britain as a whole.

Passing to some of the special services created and maintained during the War, we find credit justly given to the Emergency Public Health Laboratory Service, organised by the Medical Research Council and now destined to remain as an integral part of the new health services. The Emergency Medical Service, with its vast hospital provisions for civil and military battle casualties and sick, and its first-class special hospital units for thoracic, facio-maxillary and head injuries, not only met the needs of many urgent situations, including the bombing offensives of the enemy and our own invasion of Europe, but resulted also in an upgrading of the hospital services of the country and helped to prepare the way for the unified hospital service which the new Health Bill envisages. Civil defence, shelter accommodation and shelter health provisions, the establishment of rest centres and the extension of day nurseries, were among the many other concerns of the Ministry of Health working alone or in conjunction with other ministries. Action in anticipation of introduced epidemic diseases from abroad, including typhus, smallpox and malaria, was taken at the ports and elsewhere. The care of the aged and infirm and of numerous children and other refugees from the Continent was a further responsibility. There were remarkable developments in therapeutics, especially in the use of penicillin and the sulphonamides, and of new protective insecticides such as D.D.T.

Sir Wilson Jameson pays tribute to the numerous expert advisers, specialists and general practitioners, to much generous American aid, and especially to the medical officers of health, who between them made this vast organisation and achievement possible.

The obvious comment is that if so much can be accomplished in face of the difficulties and under the impetus which war provides, what might not be achieved by similar 'combined operations' as between administrators, men of science, consultants, practitioners and the ancillary medical and social services, in times of peace. The sciences as a whole put more into destructive effort during these six years than had ever before been deemed possible, but the medical and allied sciences at least demonstrated by contrast and in comparable measure what a part they can play in the saving of life and limb and in the considered protection and improvement of a people's health.

In concert with the fuller descriptions which will later appear in the official medical history of the War, this report—with its sober, factual descriptions—will provide an enduring testimony to much wise prevision and to some very notable conquests.

OBITUARIES

Dr. Walter Arndt

It is with much regret that we learn of the death in 1944, at the hands of the Gestapo, of Dr. Walter Arndt, of the Museum für Naturkunde (section · Zoologisches Museum), Berlin.

Dr. Arndt was a prolific writer on sponges; beginning in 1912, then after a lapse of years due to the First World War, he contributed upwards of fifty publications between 1922 and the year of his death. There is only a comparatively small amount of original research to his credit; but this little is reliable and well done. His main contribution was as a compiler, and in this he was extremely thorough. A good example of his work is seen in the contribution "Schwammo" in "Die Rohstoffe des Tierreichs", Bd. 1, 2 Halfte, 1937, p. 1,577. In this he has brought together an astonishing wealth of facts and statistics relating to bath sponges. But whether in the writing of a compilation of data, of a handbook, a dissertation on museum technique or a systematic paper, there is always conveyed an impression of painstaking attention to accuracy of detail, and of a desire to bring together any knowledge or obscure facts that might make the work more comprehensive.

Born in 1891, at Landeshut, Silesia, Dr. Arndt studied in Breslau under Kükenthal. He received doctorates both of medicine and philosophy (zoology), a fact which doubtless explains the broad field his writings usually contrived to cover.

A prisoner in Russian hands in the First World War, in the Second, Dr. Arndt appears to have been a staunch anti-Nazi. According to a letter written by his sister, he was arrested in his room at the Berlin Museum on January 12, 1944, as the result of a denunciation by a colleague and a friend of long standing. On May 11 he was condemned to death for 'defeatism' by the so-called Peoples' Court in Berlin. Several petitions were submitted for his pardon, all of which failed, because Arndt in the face of death would not retract the anti-Hitler and anti-war statements which formed the ground for his denunciation. He was executed on June 26 in the prison at Brandenburg.

It was never my privilege to meet Dr. Arndt, although I had often corresponded with him. My impression was of a kindly and courteous scholar, who spared no pains to be of the greatest assistance to a colleague. He freely responded to requests for advice, use of specimens or exchange of materials, and the rich collections of sponges in the British Museum have been enlarged to an appreciable extent by Dr. Arndt's friendly actions.

Maurice Burton

We regret to announce the following deaths:

Prof. George Baborovský, professor of physical chemistry at the Technical College, Brno, on October 10, aged seventy-one.

Sir Louis Barnett, C.M.G., emeritus professor of surgery in the University of Otago, and a founder of the Royal Australasian College of Surgeons, on which he was president during 1937–39, aged eighty-one.

Mr. A. W. Lupton, senior lecturer in pharmacy and pharmaceutical chemistry in the University of Leeds.

NEWS and VIEWS

Prof. A. W. Stewart

THE many friends of Prof. A. W. Stewart learned, with regret, of his retirement in 1944 from the chair of chemistry at Queen's University, Belfast, which he had held for twenty-five years. Educated at the University of Glasgow, the University of Marburg and University College, London, he in turn held the lectureship in organic chemistry at Belfast and the lectureship in physical chemistry and radioactivity at Glasgow, and in 1919 succeeded the late Prof. Letts as professor of chemistry at Belfast. Stewart did much to create the school from which many of his students at Belfast went to take up important positions at home and abroad. Possessed of a fertile imagination, Stewart foresaw the dangers of early specialization, and was unceasing in his labours to provide a sound and fundamental training in all aspects of modern chemistry. Thus equipped, his students found themselves ready to undertake posts of responsibility in many spheres of academic and industrial chemistry. Stewart was catholic in his interests and was ever ready to give the benefit of his counsel and experience to the young research workers. Stimulated by his close association with Ramsay and Collie, he developed a keen interest in the application of physical chemistry to the elucidation of the structure and properties of organic compounds, and his work upon Tesla-luminescence spectra was especially noteworthy. By employing a fresh method of excitation, Stewart and his co-workers obtained a series of spectra, each of which is characteristic of the compound which emits it. Thus a new constitutional property was added to those previously known and a new field in spectroscopy was developed. His many books, notably his series on "Recent Advances"—which have now reached many editions—are testimony to his love of investigation and to his interest in the welfare of the undergraduate. It is of interest to note that Stewart suggested that elements which have identical atomic weights but differ in chemical properties should be named 'isobars'. He found pleasure in more recent years in detective fiction and, using the *nom de plume* of J. J. Connington, he has given pleasure to many all over the world. In spite of physical disabilities, Alfred W. Stewart never spared himself in the many interests of teaching, research and writing, and has won the admiration and sympathy of all.

Since February 23 of this year the "Letters to the Editors" of *Nature* have been printed in very small type. As was explained when the change was made, no other course was possible by which to accommodate the great number of "Letters" awaiting publication. However, it was never intended as more than a temporary measure, and it seems to have achieved its purpose in that arrears have been overtaken and it has become possible to publish communications more promptly. The number of "Letters" submitted by correspondents is still large, but the recent increased allowance of paper has made it possible to allocate additional space to this part of the journal without encroaching on the more general parts. It has therefore been decided to revert to the larger type for printing communications submitted as "Letters to the Editors". The additional space now available, however, will do no more than allow for the increase in size of type. It is, therefore, of the greatest importance that correspondents should restrict their communications to the minimum length consistent with clearness and accuracy; in the interests of prompt publication it is also desirable that manuscript or typescript submitted should be carefully read in order to avoid the need for extensive corrections on printed proofs.

Following the official suggestion that the additional allowance of paper might be used to increase both the size of the journal and also its circulation, more copies of *Nature* are being printed to meet the considerably increased demand from many parts of the world. Readers may like to know that, for the time being, it will be possible for the publishers to accept subscription orders once more.

Chemistry at University College, Hull: Prof. Brynmor Jones

DR. BRYNMOR JONES has been appointed to the chair of chemistry in University College, Hull. Dr. Jones took his B.Sc. degree with first-class honours in chemistry and his Ph.D. degree at Bangor. After a period of three years with the late Prof. T. M. Lowry at Cambridge, Dr. Jones went to Sheffield as assistant lecturer in chemistry in 1931 and was promoted lecturer and senior lecturer in 1934 and 1939 respectively. His researches have been mainly concerned with the kinetics of the halogenation of aromatic compounds; elegant and extensive developments from the earlier experiments of the late Prof. K. J. P. Orton and his school at Bangor have been made, and the accurate velocity measurements have played an important part in the development of organic chemical theory. Dr. Jones has also published original work on a variety of topics including the rotary dispersion of organic compounds, liquid crystals, and aromatic substitution; during the War he carried out researches on behalf of the Ministry of Supply (Chemical Defence Research Department). As local representative at Sheffield and as a member of Council of the Chemical Society, Dr. Jones has given devoted services in the interests of chemistry in the Sheffield area. In addition, he has played an active part in numerous University activities, and recently he has compiled a valuable and interesting account of the contributions made by the University of Sheffield towards the war effort.

Botany at the University of Durham: Prof. Meirion Thomas

MR. MEIRION THOMAS, who has just succeeded to the chair of botany, King's College, University of Durham (Newcastle upon Tyne), went directly from Cambridge to what was then Armstrong College, to a post as lecturer on botany. This post he held until 1944, when he was promoted to a readership in plant physiology in the same Department. Throughout his stay at King's College, he has conducted with marked vigour and success various researches on the catabolic processes in plants. Most of his results are embodied in a series of papers with the general title "Studies in Zymasis"; in general, theses proceeded from the pen of Prof. Thomas himself, but occasionally they were written in collaboration with research students. In these were described the effects of oxygen, carbon dioxide and hydrocyanic acid in various gas mixtures on the zymasic breakdown of hexose. In addition to anaerobic zymasis, he has demonstrated that other types exist produced by the gases just named, and by injury and senescence. Having come to definite conclusions as to the conditions of the various forms of zymasis, he has examined the relations between the phenomenon and the incidence of physiological diseases. Naturally, during the War, the whole of these researches were suspended, or at least slowed down, by Prof. Thomas's activities in the O.T.C., in which he held the rank of captain. However, during the past year, they have been recommenced along some of the more promising lines, so that there is every probability that his tenure of the professorship will be marked by a steady flow of research papers continuing the investigations which have been so productive of results in the past.

Patterson Medal in Meteorology

THE inauguration has been announced of a Patterson Medal to be awarded annually to a resident of Canada or Newfoundland for achievement in meteorology. The Medal has been founded by the friends and professional associates of Dr. John Patterson, the retiring controller of the Meteorological Service of Canada and honorary professor of meteorology in the University of Toronto After graduating from the University of Toronto in 1900, Dr. Patterson went to the Cavendish Laboratory, Cambridge, with an 1851 Exhibition Science Research Scholarship. In 1902 he became professor of physics at the University of Allahabad, and soon afterwards he was appointed Imperial meteorologist to the Government of India. He joined the Meteorological Service of Canada in 1910 and became director in 1929. During the First World War, Dr. Patterson worked with the British Admiralty to develop a commercial process for the extraction of helium from natural gas. After the War, to meet the demands of aviation, he trained young graduates for the Canadian Meteorological Service, and when the Second World War broke out, he had already laid the foundation of a great meteorological service which was able to meet the demands of the British Commonwealth Air Training Plan. He is best known for his pioneering work in the exploration of the upper atmosphere by means of balloon meteorographs and for improvements to the cup anemometer and mercury barometer.

The announcement of the Patterson Medal was made by the Hon. C. D. Howe, Minister of Reconstruction and Supply in Canada, at a reception and dinner given to Dr. Patterson on September 28 Commander C. P. Edwards, Deputy Minister of Transport, presented him with a portrait which Dr. Patterson requested should be hung at the headquarters of the Meteorological Office along with the portraits of the six preceding directors. Commander Edwards then presented a silver platter with an inscription expressing the esteem in which Dr. Patterson is held by colleagues and other friends. In reply, Dr. Patterson said he was deeply gratified that his friends had chosen to honour him by the foundation of the Medal, since it would foster the advancement of meteorological science. Nations have founded great institutions for the development of other sciences, and scholarships and awards have been set up, yet this science, which bears upon the life of every human being, had not received the attention it merited. This was the first time in Canada that there had been any award for meteorology. The building of a good meteorological service depends, he said, on two essentials: the obtaining of basic data and the provision of technical staff capable of making the most of the data. Surface meteorological observations are only obtainable regularly from one fifth of the surface of the globe. The augmentation of basic data is taking place to-day from the upper air This data has become very expensive, by pre-war standards. The provision of a technical staff competent to make the most of this data would only add a few per cent to the total cost of the service; failure to provide this staff would be false economy.

Principles of Rheological Measurement

A CONFERENCE and exhibition of rheological research apparatus were arranged by the British Rheologists' Club during October 3–5 at Bedford College, University of London. Prof. E. N. da C. Andrade, in a presidential address, gave a survey of modern theory with special reference to metals and hard materials in general. Three sessions were devoted to the principles of rheological measurement for (*a*) soft materials under conditions of large strain, (*b*) materials of intermediate consistency, such as doughs, pastes, rubber, etc., and (*c*) steel and hard materials. Dr. L. R. G. Treloar spoke on "Technical Terms and Definitions". Mr. E. G. Ellis, chairman of the Grease Rheology Panel of the Institute of Petroleum, spoke on the measurement of the consistency of lubricating greases. Dr. K. Weissenberg with Mr. G. M. Freeman, of the British Cotton Industry Research Association, dealt with the geometry of rheological phenomena and demonstrated the practical application of the Weissenberg rheogoniometer. Dr. G. W. Scott Blair read a paper on the consistency of doughs and pastes, and Mr. J. M. Buist on the hardness testing of rubbers. In the session on hard materials, Dr. W. W. Barkas discussed the anisotropic elastic properties of wood, and Dr. E. Orowan dealt with steel and metals. The discussions were lively and well sustained: new views and an interchange of ideas were rendered possible by the presence of distinguished overseas rheologists.

The research apparatus used by members were exhibited and demonstrated during the conference. Models and graphs, such as, for example, a model illustrating tractions and composition of stress and strain tensors in a unit cube, graphs showing the flow characteristics of a grease at medium rates of shear (plunger viscometer) and at high rates of shear (pendulum viscometer) were displayed. Apparatus developed for special industrial purposes were shown: these included instruments for the measurement of creep of dielectrics, the consistency of curd in cheese-making, a rotational viscometer for fabric-printing thickeners, oil viscometer with a high range of shear rate, etc. On October 5 visits were made to the science laboratory of Mr F. I. G. Rawlins at the National Gallery, to the G. E. C.-Osram glass works, Wembley, and the Building Research Station, Garston, where members were able to observe how rheological methods are being used in the arts and industry. Publication of the proceedings of the conference is being arranged, and it is hoped that copies also of "Essays in Rheology" (Oxford Conference) will be available in the new year.

Developments in Agricultural Machinery

AT the fourth annual inspection by the Agricultural Machinery Development Board held at the National Institute of Agricultural Engineering, Askham Bryan, on October 2, a number of interesting demonstrations were arranged to illustrate the work in progress at the Institute The new sugar beet harvester on view incorporated several improvements on the model shown last year, notably the 'topper-picker' and 'sweeping wheel' which had undergone successful trials late in the previous season. The beet is topped while still in the ground, and beet and tops are delivered into separate windrows. No elevator chains or rollers are used, thus considerably reducing the wear from soil abrasion. Work in progress for the production of a simple machine for assisting in the harvesting of a variety of root crops such as swedes, mangolds, carrots or potatoes was also demonstrated, while the provision of an efficient potato digger suitable for the small grower was a further proposition undergoing investigation. The main exhibit in the plough section was a mounted one-way 3-furrow plough designed and built at the Institute. This 'reversible' type requires less skill in operation, leaves a level field without ridges or open furrows, and when direct-mounted should effect considerable saving in time and fuel. Combine harvesters have introduced problems of handling, drying and storing grain in bulk, and much research work at the Institute has been devoted to their solution. Among the range of machinery shown for use in conjunction with a small combine, were installations for the drying of grain by ventilation with slightly heated air during storage, and a modified form of the automatic drier that was a feature of the exhibit of last year.

Additions to the Irish Flora, 1939–45

SINCE the publication by Lloyd Praeger of "Irish Topographical Botany" in 1901, there have been seven supplementary papers which have kept our knowledge of the distribution of higher plants in Ireland up to date; the eighth of these (*Proc. Roy. Irish Acad.*, 51 B, (3), 27; 1946) is, as Dr. Praeger says, probably the last which will be published under his own name. Nevertheless, the number of records bearing a sign indicating that the author himself had seen either a plant in its locality or a specimen from there, is a remarkable tribute to the energy and capability of a botanist who has passed his eightieth year. The present paper contains first records for the forty vice-counties together with extensions and diminutions in the areas of interesting species. Unlike earlier lists, 'introduced' species are included. Of especial interest are the remarks concerning the North American *Myriophyllum alterniflorum* var. *americanum* and the South American *Margyricarpus setosus*, while the known ranges of such species as *Erica vagans*, *Sisyrinchium angustifolium*, *Naias flexilis*, *Eriocaulon septangulare* and several others show interesting extensions. The difficult species of *Allium* are elucidated, and the nomenclature of those species of *Hieracium* and *Euphrasia* which occur in Ireland are revised according to the schemes of Pugsley. The paper is concerned, too, with suggestions as to areas in which certain species and hybrids should be sought, indicating that the author, although a veteran, is still alive to future possibilities. This is shown, too, by his continued emphasis on the necessity for a *biological* survey by geologists, botanists and zoologists of the extremely interesting Lough Neagh, where he is convinced that such a team would reap a rich harvest.

The Indian Forest Research Institute

THE annual report of the Forest Research Institute, Dehra Dun, for 1942–43 increasingly shows how the work continued to be interrupted by the War and its demands (For. Res. Inst. Public., Vasant Press, Dehra Dun, 1945). The report, it is of interest to mention, is printed on paper made in the Paper Pulp Section of the Forest Research Institute from saplings of *Pinus longifolia* from forests not so very far distant. The first chapter of the report summarizes the work of the different branches, the remaining chapters giving the reports of the year's work by each branch. Most of the branches had to suspend all their ordinary work to deal with urgent demands of the Fighting and Civil Forces, the exceptions being botany and sylviculture, though the rubber scarcity and search for supplies provided work for both of them. It is a curious fact that the individual 'branches' of a research institute acquire the habit of working in water-tight compartments. Dehra Dun was no exception. The president, Sir Herbert Howard, writer of this report, deplores this fact of the past and says that the War has forced co-operation upon the branches and sections, with valuable results, which it may be hoped will be maintained to the benefit of the Institute. Where all branches have been more or less closely engaged upon war-time research, reference to the report must be made for details.

It is remarkable that the so-called minor forest products of India have never received their recognition in the Institute as a separate branch with an officer in charge. Their importance and effect on India and its commerce can still be only suspected. For example, during the year 1942–43, among other things, a source of pectin from tamarind seeds which had previously been wasted was developed. This pectin gives excellent material for jellies, and its further development has given a gum of the tragacanth type which is the only material at present available for creaming rubber latex, for which it is entirely suitable. It has also been successful as a sizing material for textiles. The commercial possibilities of this are said to be very great. Suitable species for producer gas, and an investigation into various species as sources of rubber production has also occupied the activities of the branch.

Archæology of the Illinois River Valley

A REPORT, upon work done under the auspices of the University of Illinois in 1928, deals with the archæology of a small part of that State (*Trans. Amer. Phil. Soc.*, 32, Part 1: "Contributions to the Archæology of the Illinois River Valley". By Frank C. Baker, James B. Griffin, Richard G. Morgan, Georg K. Neumann and Jay L. B. Taylor. Edited by James B. Griffin and Richard G. Morgan. Pp. iv+208+68 plates. Philadelphia: American Philosophical Society, 1941). Excavations were made in a number of mound-groups, and a village site was reconnoitred. Most of the mounds belong to the comparatively well-known Hopewell mound-building culture, a single mound-group belongs to a later phase, the Middle Mississippi, and the village site and one mound are ascribed to the Woodland-culture pattern, probably later still. The second part of the report is devoted to a study of the fauna associated with the sites, and the third to some skulls from the Woodland-culture mound. The value of the report lies in supplementing our information about the distribution of the cultures found, and is enhanced by a map and classified list of archæological sites in Illinois at the beginning. It would have been easier to follow had the descriptions of sites been arranged in some intelligible kind of order, segregating those of various cultures. The introduction says that it was impossible to include the maps and diagrams of the sites; the inclusion of at least some of them would undoubtedly have been an advantage.

Mineral-insulated Metal-sheathed Conductors

IN a recently published paper (*J. Inst. Elec Eng.*, 93, Part 2, No. 34, Aug. 1946), Messrs. F. W. Tomlinson and H. M. Wright discuss the development and uses of metal-sheathed conductors employing as insulating medium highly compressed magnesium oxide powder. In consequence of the high-temperature stability and the good insulating properties of this material, these conductors have found wide application as electrical heating elements in radiant boiler-plates and as power supply cables in circumstances where the avoidance of fire-risk is of special importance, or where the ambient temperature or atmospheric conditions are too severe for other types of electric cable. The low dielectric loss exhibited by magnesium oxide at very high frequencies, combined with the other advantageous characteristics mentioned, has also enabled specially designed cables to be used for certain important radar purposes.

Status of Translations and Translators

IN his pamphlet "On Translations", reprinted from *Life and Letters*, Sir Stanley Unwin directs attention to some of the problems arising in translation from one language to another, and to inadequacies and inaccuracies still encountered, although during the past forty years the quality of translations into English and the status of translators have steadily improved (London: Allen and Unwin, Ltd. Pp. 8. 6*d*. net). Sir Stanley emphasizes that first and foremost the translator should be adequately paid, and payment for translation should be a first charge, taking precedence over the author's remuneration. The translator's name should always be given, provided it is his (or her) exclusive work, and it should be a universal practice to print, on the back of the title-page of any translation, the title of the original work. The best remedy for mistranslation and for deliberate tampering with the text is informed criticism; bad translations should be denounced. Authors should help by giving preference to publishers who take pride in the quality of their translations and maintain a high standard; but while the publication of translations is in general more speculative than the issue of original work, Sir Stanley does not agree that the publication of translations should be financed by governments. If, however, for commercial reasons any work of outstanding importance had remained untranslated for, say, five years, governments would be well advised to offer to bear the cost of translation, if a publisher was willing in that event to produce the work at his own risk and expense. The pamphlet also includes some notes on "Our Universal Language", which stress the importance of the new demand for British books.

Museums of To-morrow

DR. D. A. ALLAN'S presidential address on the occasion of the Museums Association's annual conference at Brighton this year is reported in full in the *Museums Journal* of August. Under the title, "Museums—*Mutatis Mutandis*", Dr. Allan advocates more teaching in the museum and less congestion of exhibits, and he is of the opinion that museums should not strive to increase already immense collections "To perform its function adequately," he says, "each museum, large or small, must adopt a plan and work it out. It is not enough merely to tidy-up a museum; it must be put into working order; it must show less and teach more." He also appeals for the establishment of special museums to demonstrate the history and applications of British mechanical invention and engineering, mining and agriculture, and looks for the further development of folk museums so that there may be one to each distinctive region of the British Isles.

Economics of International Trade

IN Pamphlet No. 7, "International Trade", in the "Looking Forward" series issued by the Royal Institute of International Affairs, G. A. Duncan points out first that international trade between two countries really means a multitude of independent transactions linked by nothing more serious than the accident that their participants happen to live in two politically defined areas; hence, while all the problems, spurious as well as real, would still be there if the world was politically unified, they would not be linked up with political units and political power. He then attempts to set out the nature of the principal questions that arise on the assumption that one State, one supreme political government, embraces the whole earth. The complications introduced by the existence of sixty-odd sovereign and independent States are then considered, and the conditions precedent to the revival and growth of international trade in the post-war world are indicated. International trade, Mr. Duncan argues, consists of an economic substratum overlaid by a political scum. The economic reality is that the real welfare of the world's human population is a function of the optimum use of its diversified resources—mineral, vegetable, animal and human—under contemporary conditions of technical knowledge.

The optimum pattern, according to Mr. Duncan, is not a matter of merely technical comparison, but of economic balancing, taking into account differing valuations of resources in differing areas, and the correct distribution can only be determined by the empirical method of competition, which continually presents the dilemma of choice between immediate, localized and vocal loss, and more distant, diffused and inarticulate gain. The competitive process can only yield its dividends when it is allowed to proceed so far as possible on economic grounds. The political scum consists of the arbitrary importance attached to trade crossing political frontiers and to the significance of partial calculations about its component elements; the tendency to think of international trade as trade between definable political entities instead of an arithmetical accident; and the invasion of economic problems by notions of political power and prestige. The problem for economic statesmanship in the next few years, he concludes, is that of working out by common agreement a form and extent of political impositions upon international trade that will inhibit its growth as little as possible, while satisfying all reasonable political desires.

Bibliography of Seismology

THIS valuable bibliography is being continued by Dr. Ernest A. Hodgson; *Pub. Dominion Observ., Ottawa*, **13**, Nos. 16, 17 and 18, comprise items 5788–6046. The bibliography is concerned with publications in pure and applied seismology and other subjects having a direct bearing on seismological problems. It is pleasing to see notes of Russian work, much of which was done during the War. One such is by E. E. Petrenko, "A Net of Co-ordinates for Determining the Epicentre of an Earthquake" (*Akademiia Nauk, U.S.S.R., Trudy Seismolog. Inst.*, No. 106, 12–16, Moscow, 1941). This is in Russian, but it has been translated by W. Ayvazoglow and V. Skitsky for *Geophysical Abstracts*. Greek work is largely centred on the collected papers of Prof. N. A. Critikos, published by his colleagues on the occasion of the thirty-fifth anniversary of his scientific work (Item 5901). An especially important piece of American work is listed as Item 5956, by D. S. Carder, "Seismic Investigations in the Boulder Dam Area 1940–41, and the Influence of Reservoir Loading on Local Earthquake Activity" (*Bull Seis. Soc. Amer.*, **35**, No. 4, 175–192, Oct. 1945). This work has been particularly successful in locating epicentres of small shocks and associating them with fault planes. It may easily have far-reaching results on reservoir engineering. Considerable useful work has been done in New Zealand; for example, Item 5980, by W. M. Jones, refers to three papers, including "Determination of Epicentres in the South Pacific from Differences in the Arrival Times of ScS" (*N.Z. J. Sci and Tech.*, **26**, No. 6B, 360–369). This paper shows that there is less ambiguity in epicentral determination using *ScS* pulses than when using *P* pulses in certain cases owing to loss variation caused by the depth of focus. British work is mentioned, including Item 5862, Prof. H. H. Plaskett's tribute to the seismological work of Miss E. F. Bellamy; Item 5880, Sir George Simpson's tribute to the work of the late Dr. F. J. W. Whipple; and Item 5930, by Dr. R. Stoneley, "Earthquakes" (*Observ.*, **66**, No. 824). There is also a list of references published in *Nature*.

University of London: Appointments

THE following appointments have been made: Dr. C. A. Hart, to the University chair of surveying and photogrammetry tenable at University College as from October 1; in 1927 he became assistant lecturer in the Department of Municipal Engineering and Hygiene at University College, and during 1942–46 he was officer in charge of research, Directorate of Military Survey, War Office: Dr. C. V. Harrison, to the University readership in morbid anatomy tenable at the British Postgraduate Medical School as from October 1, 1946; Dr. Harrison was formerly lecturer in pathology in the University of Liverpool, and since 1944 has been chief pathologist to the Ministry of Supply and chief consultant in pathology to the Admiralty.

The following doctorates have been conferred: *D.Sc.*: Mr. W. E. Duncanson, recognized teacher of University College; *D.Sc.(Eng.)*: Dr. Harold Heywood, Imperial College of Science and Technology; *D.Sc.(Econ.)*: Mr. K. H. L. Key, Institute of Education.

Re-opening of the British Museum (Natural History)

THOSE portions of the British Museum (Natural History) that have been restored have been re-opened to the public. The hours of opening are 10 a.m.–6 p.m. on weekdays, and 2.30 p.m.–6 p.m. on Sundays. The Museum suffered considerably from bomb-blast and fires resulting from air raids during the War. Little or no irreplaceable material was lost, as all the most valuable specimens had been evacuated to places of safety. But the Botanical and Shell Galleries were destroyed (the latter fortunately being empty at the time), and in many of the galleries exhibits were damaged, notably those of birds and mammals in the Western Wing. The Museum has been re-opened as soon as the minimum of essential repairs could be completed, but as yet the public can be admitted to only a few of the galleries on the ground floor, namely, the Central and North Halls, the Fish Gallery, the Insect Gallery, the Reptile Gallery and the Whale Hall. Selections of specimens from the more seriously damaged parts of the exhibition are on view temporarily in these galleries. As the work of repair and reconstruction proceeds, more galleries will become available for exhibition purposes and will be re-opened.

Announcements

PROF. C. H. LANDER, who has just retired from the chair of mechanical engineering at the City and Guilds College, University of London (see *Nature*, August 10, p. 191), has been appointed dean of the Military College of Science.

DR. JACOB BAKKER, of the Netherlands State Coal-mines, has joined the National Coal Board in Great Britain as adviser to the chief mining engineer. He is widely recognized throughout the coal-fields of Europe as a leading expert on 'horizon mining', that is, driving main roadways straight out from the pit-bottom and working the coal wherever it is struck.

DR. FRANK BELL, principal of Lancaster Technical College since 1941, has been appointed professor of chemistry at the Belfast College of Technology in succession to Dr. Henry Wren. Dr. Bell has held previous appointments at the Wellcome Chemical Research Laboratories, Blackburn Technical College and Battersea Polytechnic.

A David Anderson-Berry Silver-Gilt Medal, together with a sum of money amounting to about £100, will be awarded during 1947 by the Royal Society of Edinburgh to the person who, in the opinion of the Council, has recently produced the best work on the therapeutical effect of X-rays on human diseases. Applications for this prize are invited. They may be based on both published and unpublished work and should be accompanied by copies of the relevant papers. Applications must be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, not later than January 31, 1947. It should be noted that an extension of the period allowed for the receipt of papers has been made.

ERRATUM. The "wonderful one-hoss shay" re-referred to in *Nature* of October 19, p. 537, was wrongly attributed to Longfellow; the phrase comes from Oliver Wendell Holmes' "The Deacon's Masterpiece".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

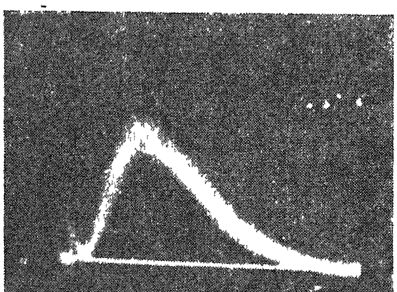
Observation of Spectral Lines with Electron Multiplier Tubes

CONSIDERABLE interest has been shown within the last two or three years in technical developments relating to spectroscopic analysis. Since the advent of several new controlled sources[1,2], including a circuit devised by Mr. C. J. Braudo, in this Laboratory and recently described briefly[3] (a full communication has been prepared), great importance has become attached to observations of any residual fluctuations in spectral-line intensities, because the irregularities in breakdown voltage of the test gap have been almost entirely eliminated by these new circuits.

A descriptive paper, giving details of multiplier observations of certain dynamic gas discharge effects, has recently appeared[4], and was followed by details of a multiplier technique for spectroscopic analysis[5]. It is therefore considered worth while to give a short summary of the experiments carried out in this Laboratory since 1943.

The development of reliable sealed-off triggered spark gaps[6] enabled us to use controlled spark sources for spectroscopic and other experiments some three years ago. Despite the accurate repetition of breakdown voltage and current (observed oscillographically) in the spark discharges then used, it was noticed that considerable fluctuations in light emission from argon spark discharges occurred[7,8].

This work led to several developments. among them were (*a*) the more refined spectroscopic source unit[3], (*b*) work on the accurate determination of ion concentrations in hydrogen spark discharges[9,10], and (*c*) some new observations of the excitation of metal electrode vapour in spark discharges.



The accompanying typical record for the Cd line 5085 A. is a photographic reproduction of the oscillograph screen. The vertical axis gives line intensity, using the amplified current from an electron multiplier excited from the sparks via a spectrometer, while the time axis is horizontal. The pulse is about 4 microsec. long, and is therefore that of a pure spark source. The circuit[3] mentioned above provides, if required, a follow current to give a discharge of arc type. Some preliminary multiplier measurements with this compound source were made early in 1946 and are to be extended.

We have observed fluctuations in the intensities of electrode vapour spectral lines (the thickness of the trace in the trace reproduced compared with that of the zero line is illustrative) which do not appear to be explicable on the grounds of circuit variations from spark to spark, and it appears possible that these fluctuations (now being studied) are linked with those observed in 1943[7] for purely gaseous (argon) discharges.

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Sept. 11.

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[8] Craggs, J D, and Meek, J. M, *Proc Roy. Soc*, A, **186**, 241 (1946).
[9] Craggs, J. D., and Meek, J M, *Nature*, **156**, 21 (1945)
[10] Craggs, J D, and Hopwood, W., to be published shortly

Changes in Cosmic Ray Intensity Associated with Magnetic Storms

IT is usually supposed that the world-wide changes in cosmic ray intensity associated with a magnetic storm are due to variations in the earth's magnetic field produced during the storm. This seems to be excluded, however, by recent observations by Lange and Forbush[1], who have found that the intensity varies (decreases *and increases*) even at Godhavn, which is situated at so high a geomagnetic latitude (80°) that the earth's magnetic field cannot possibly affect the intensity. Further, the variations cannot be due to changes in the solar magnetic field, because they are observed even at Huancayo, which has a low geomagnetic latitude (0·6°) so that it is reached only by the high-energy particles which are certainly not influenced by the solar magnetic field. Then the only possible explanation seems to be that the variations in cosmic radiation are due to changes in the earth's electrostatic potential.

There are strong arguments in favour of the view that magnetic storms are caused by ionized clouds emitted from the sun. As the time of travel from the sun to the earth is about one day, their average velocity is of the order of $1{\cdot}5 \times 10^{13}/0\ 864 \times 10^5 = 2 \times 10^8$ cm./sec. The solar magnetic field at the distance of the earth is likely to be 3×10^{-6} gauss (assuming a dipole field with about 50 gauss at the pole). Any electrical conductor (and the ion cloud is certainly conducting), which moves in a magnetic field, becomes polarized, the electric field strength being $E = vH/c$, which in our case gives $3 \times 10^{-6} \times 2 \times 10^8/3 \times 10^{10} = 2 \times 10^{-8}$ E.S.U. $= 6$ μvolt/cm. As storms often endure for, say, two days, the breadth of an ion stream emitted from the sun (and sharing the solar rotation, as shown by the 25-day recurrency of storms) should be $2/25 \times 2\pi \times 1{\cdot}5 \times 10^{13}$ cm. at the distance of the earth ($1{\cdot}5 \times 10^{13}$ cm.). This means that there must be a difference in potential between the two sides of the stream of $6 \times 10^{-6} \times 8 \times 10^{12} = 50 \times 10^6$ volts, the east (advancing) side being negative. As indicated by a theory of magnetic storms[2] proposed some years ago and by recent model experiments by Malmfors[3], the electric field strength during a storm may be considerably greater, so that potential differences of some hundred megavolts, in exceptional cases still more, would be possible. But even the above value (50 MV.) is no doubt enough to affect the cosmic radiation appreciably. As the earth quickly attains about the potential of the stream, it would be negative in the beginning and positive at the end of a storm, resulting in an increase and later a decrease of cosmic radiation. This seems to be in general accord with what is observed.

Near other stars the same mechanism may give rise to still higher differences in potential. This is of interest with regard to the point of view[4] according to which the cosmic radiation may be generated in electric fields produced by magnetic induction.

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Sept. 28.

[1] Lange and Forbush, *Terr. Mag.*, **47**, 331 (1942).
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[3] Malmfors, K. G., *Arkiv for mat. astr fysik.*, Bd. 34, B, No. 1 (1946)
[4] Alfvén, H., *Z. Phys.*, **107**, 579 (1937); *Nature*, **143**, 435 (1939).

Dielectric Dispersion in Crystalline Di-isopropyl Ketone

DIPOLAR rotation is well known to occur in a number of organic crystals, for example, *d*-camphor[1] and cyclopentanol[2], and in ice[3,4] far below the melting point. The dielectric behaviour of these substances is remarkable in that solidification is only shown as a minor discontinuity of the polarization curve, and it may be said that such compounds do not freeze dielectrically at their macroscopic freezing point. In some cases, dipolar rotation stops at a transition taking place at a lower temperature. Whether or not dispersion is observed in the crystalline state should depend on the frequency used.

It appears to be interesting that the dipolar rotation in crystalline di-isopropyl ketone, found in the course of another investigation, presents a different picture. Fig. 1 gives its dielectric constant ε' at two frequencies, and Fig. 2 the loss factor ε'' at three frequencies, measured by a resonance method, details of which have been given elsewhere[5]. The sample was fractionated under nitrogen, b.p. + 123° C., $n^{17\cdot5}{}_D = 1\cdot4107$, but it was found that its dielectric properties were little different from the untreated commercial product. The substance melts between − 72 5° and −73·5° C. When approaching this point from higher temperatures, ε' and ε'' increase, the rise of ε'' indicating incipient anomalous dispersion. The liquid supercools generally to about − 80°, and crystallization is accompanied by a sharp drop of the dielectric constants; but ε' falls to a value appreciably higher than would be expected in a crystalline solid (that is, about n^2) and depends on the frequency. The reason for this frequency dependence is the occurrence of anomalous dispersion in the crystalline state shown by the peaks of ε'' in Fig. 2 and by the sigmoid shape of the ε'-curves in Fig. 1. The dielectric constant ε' assumes its final value of about 2·4 on the low-temperature side of the dispersion range.

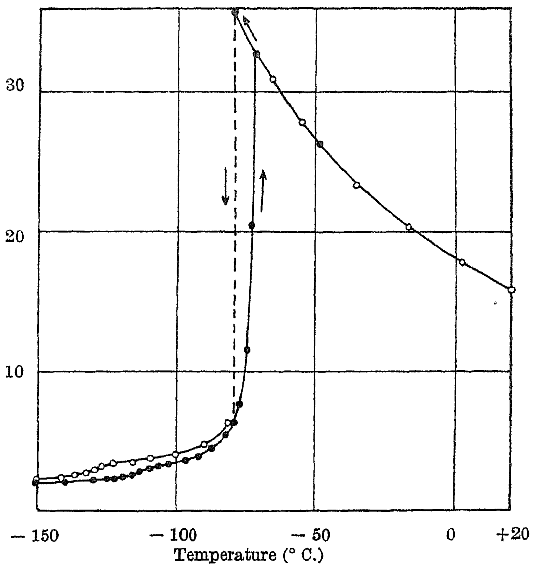

Fig. 1. DIELECTRIC CONSTANT, ε', OF DI-ISOPROPYL KETONE: —○—, at 1·12 Mc./s., —●—, at 20 4 Mc /s.

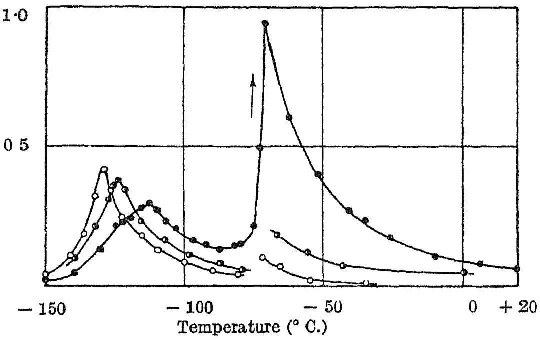

Fig. 2. LOSS FACTOR, ε'', OF DI-ISOPROPYL KETONE· —○—, at 1 12 Mc./s, —◑—, at 4·4 Mc./s., and —●—, at 20 4 Mc /s.

Measurements made at rising temperature give a gradual increase both of ε' and ε'' just below the melting point until the points coincide with those taken at falling temperature. Müller[6] found this pre-melting effect on ε' in two straight ketones of higher molecular weight but no dispersion in the crystalline material.

In contradistinction to the substances mentioned above, the crystallization of di-isopropyl ketone has a profound influence on the polarization, and there is no sign of another transition below the melting point. It is tentatively suggested that branching of the molecule causes a crystal lattice somewhat looser than that of straight ketones and reduces the intramolecular forces sufficiently to allow restricted molecular rotation.

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Herts. Sept. 30.

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Crystal Structure of Zinc *p*-Toluenesulphonate

CERTAIN hydrated salts of benzenesulphonic acid and related acids exhibit interesting isomorphous relationships[1]. An X-ray examination of the unit cells and space groups of a number of these salts indicates that the variable element (the metal atom) in the isomorphous series lies at symmetry centres in the unit cell. It should, therefore, be possible to determine the crystal structures of these materials by the direct method of Fourier synthesis used by Robertson for phthalocyanines[2,3], in which no preliminary assumptions are made about the stereochemistry of the structure. The structure of one of the salts, zinc *p*-toluenesulphonate, $(CH_3.C_6H_4.SO_3)_2$ $Zn.6H_2O$, has now been examined by Fourier synthesis, and the results are given briefly in this note.

The isomorphous relationship between zinc *p*-toluenesulphonate and magnesium *p*-toluenesulphonate, indicated by goniometric data for these materials[4], is confirmed by X-ray examination. The monoclinic unit cells of the crystals are chosen so as to conform with the goniometric data, and the cell dimensions are $a = 25{\cdot}3$ A., $b = 6{\cdot}2_9$ A., $c = 6\ 9_8$ A., $\beta = 88{\cdot}5°$ for zinc *p*-toluenesulphonate, and $a = 25{\cdot}2$ A., $b = 6{\cdot}2_6$ A., $c = 6{\cdot}9_5$ A., $\beta = 88{\cdot}1°$ for magnesium *p*-toluenesulphonate.

The space group is $P2_1/n$ (C^5_{2h}), and the measured densities are $1{\cdot}55_1$ (zinc salt) and $1{\cdot}42_0$ (magnesium salt), whence the contents of the unit cells are two centro-symmetrical groups of composition $(CH_3.C_6H_4.SO_3)_2$ $Zn.6H_2O$, and $(CH_3.C_6H_4.SO_3)_2$ $Mg.6H_2O$, respectively, with the metal atoms situated at symmetry centres.

Fig. 1 is a contour map showing the projection of the electron density of zinc *p*-toluenesulphonate along the direction of the *b* axis. Fig. 2 is deduced from Fig. 1 and represents the structure of zinc *p*-toluenesulphonate projected along the *b* axis [010]. The projected electron density has been calculated by the summation of a two-dimensional Fourier series of 165 terms. The relative phases of the Fourier terms have been determined experimentally[2], by comparing the measured structure amplitudes for corresponding reflexions from zinc *p*-toluenesulphonate and magnesium *p*-toluenesulphonate.

All the atoms in zinc *p*-toluenesulphonate can be clearly identified in Fig. 1, with the exception of one oxygen atom, (O_I), of the sulphonate group. The peak identified as the sulphur atom is nearly circular, but rises to a considerably greater height than may be expected for a sulphur atom alone, suggesting that the oxygen atom O_I is directly superimposed on the sulphur atom. This interpretation is supported by the observation that the projected positions of the atoms O_I, O_{II}, O_{III}, C_I are consistent with a regular tetrahedral distribution of these atoms about the sulphur atom. It is noted also that the distribution of water molecules in Fig. 1 is consistent with a regular octahedral grouping of six water molecules about each zinc atom.

It is necessary to determine the third co-ordinate of each atom before precise details of the stereochemistry of the structure can be given, and work is now proceeding with this end in view.

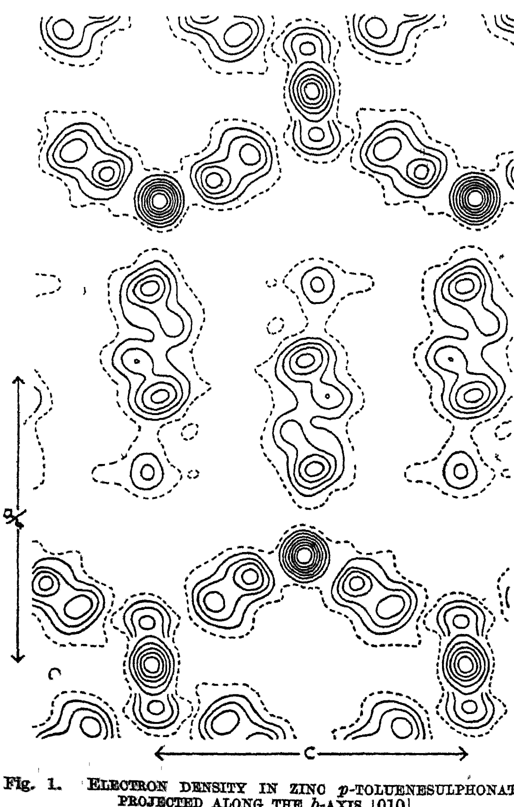

Fig. 1. ELECTRON DENSITY IN ZINC *p*-TOLUENESULPHONATE PROJECTED ALONG THE *b*-AXIS [010]

The contour lines enclosing the zinc atom and the (sulphur + oxygen I) group are drawn at intervals of 8 electrons per A.² and 4 electrons per A.² respectively: the remaining contours are drawn at intervals of 2 electrons per A.², and the 2-electron line is dotted

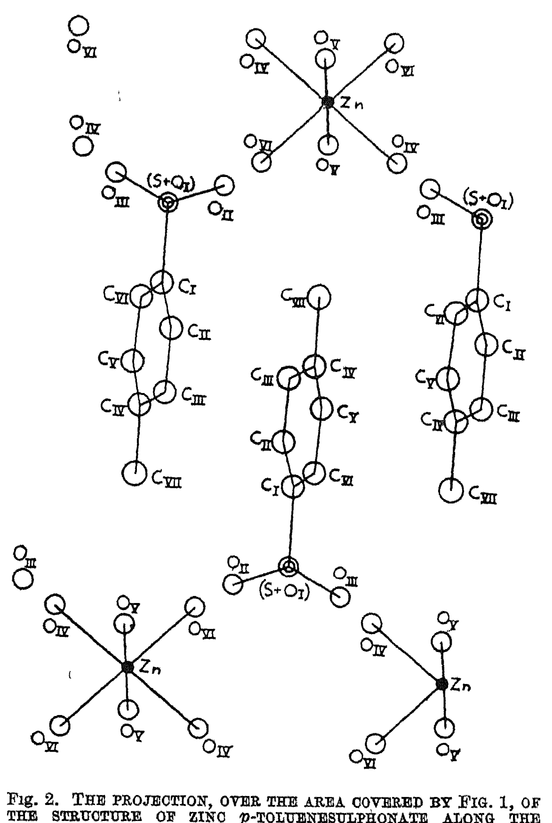

FIG. 2. THE PROJECTION, OVER THE AREA COVERED BY FIG. 1, OF THE STRUCTURE OF ZINC *p*-TOLUENESULPHONATE ALONG THE *b*-AXIS [010]

I am indebted to Messrs. Imperial Chemical Industries Limited (Dyestuffs Group) for supplying the crystals used in this investigation.

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[1] Groth, P. H., "Chemische Krystallographie", vol. 4, p 297
[2] Robertson, J. M., *J. Chem. Soc.*, 1195 (1936)
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[4] Weibull, M., *Z. Krist.*, **15**, 234 (1889).

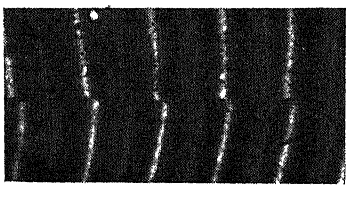
Measurement of Thickness of Thin Films

TOLANSKY has shown in a recent series of papers[1] that interference fringes formed by multiple reflexion between highly reflecting surfaces can be applied with great effectiveness to the study of surface topography. Thus Tolansky has been able to detect abrupt changes of only 20 A. in level in cleavage surfaces of mica. We have recently applied this technique to the determination of thickness of thin layers of gold, silica, collodion and 'Formvar', which are widely used for supporting and other purposes in electron microscopy.

A typical sample of the appropriate thin film is, in preference, prepared in contact with a smooth glass surface. The film is arranged to cover only a part of the plate so that an abrupt step of depth equal to the thickness of the film is present at some position on the surface. Such a step may be formed by any appropriate method, for example, by shading part of the glass plate in the case of films formed by evaporation or by using the natural boundary of a portion of film in the case of plastic films. The composite surface thus formed is coated with a thin layer (300–400 A. say) of silver by evaporation *in vacuo*, and the silvered film placed in substantial contact with a similarly silvered second glass plate. Fizeau fringes are formed by the plates by using a collimated, filtered beam ($\lambda = 5460$) from a high-pressure mercury-vapour lamp (Metrovick ME 250). The localized fringes are viewed in transmission with a low-power microscope and show in general smooth contours broken by an abrupt shift occurring at the film boundary. Fringe shifts of 1/200 of an order can be detected (that is, about 15 A. in film thickness), and thus the method is suitable for the measurement of films of thickness 100 A. and above.

The nature of the glass plates used in the apparatus merits some attention. Good quality sheet glass (for example, a lantern slide cover) proves particularly suitable, and indeed for smoothness of contour shape is superior to good quality optically worked glass. The reason for the superiority of sheet glass in this respect is presumably due to a small-scale smoothness of surface in 'fire-polished' glass that, as was anticipated, was absent in mechanically polished glass.

A typical photograph is reproduced of the fringe shift associated with a collodion film 390 A. thick. We have successfully applied a similar technique to the measurement of evaporated films of silica and gold



(using reflected fringes in the latter case), and we have also measured the optical thickness and consequently the refractive index of silica and collodion films.

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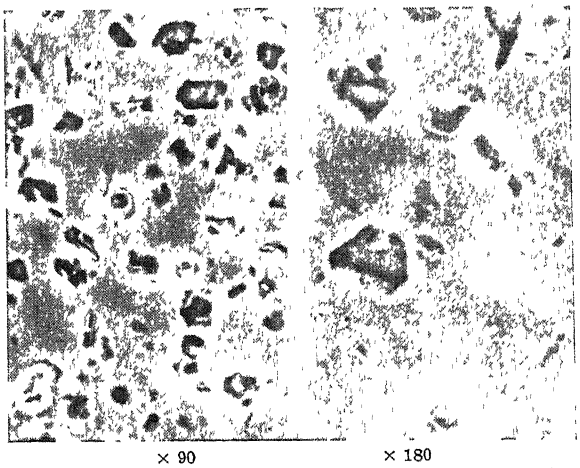
[1] Tolansky, *Proc. Roy Soc.*, **184**, 41 (1945), **186**, 261 (1946) and earlier papers.

Phase-Contrast Microscopy for Mineralogy

PHASE-CONTRAST microscopy has in recent years been applied to a number of biological problems[1,2,3], but up to the present no results of its application to mineral substances appear to have been published. I recently suggested to Messrs. Cooke, Troughton and Simms, Ltd., that as they were preparing phase-contrast equipment for biological work, it would be of interest to determine whether the same methods would be of value in micro-mineralogy. As a test, they kindly allowed me to examine by this method some of my mineralogical slides, and from some they prepared photomicrographs.

In thin sections, the structures of rocks containing colourless minerals of similar refractive indices (for example, quartz and the felspars) showed up very clearly with phase contrast; in these cases a further improvement in the image sometimes resulted from the use of a single 'Polaroid' filter placed in the beam. In Canada balsam mounts of china clays, the shapes of the larger particles were clearly seen. The photomicrographs reproduced here are sufficient indication that the technique represents a development which the mineralogist ought not to neglect.



× 90 × 180

CRYSTALS OF KAOLIN, CORNWALL, PHOTOGRAPHED BY MEANS OF THE PHASE-CONTRAST MICROSCOPE

The phase-contrast equipment used in the above work consisted of a special condenser with annular diaphragms and a set of four objectives, giving magnifications of 10, 20, 40 and 95, each with its integral phase plate. The photographs reproduced above were taken with the lower-power objectives and a 12× eyepiece.

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[1] Burch, C. R., and Stock, J. P. P., *J. Sci. Instr.*, **19**, 71 (1942).
[2] Richards, O. W., *Nature*, **154**, 672 (1944).
[3] Brice, A. T., Jones, R. P., and Smyth, J. D., *Nature*, **157**, 553 (1946).

Viscosity of Associated Liquids

An equation representing the temperature variation of the viscosity (η) of water and lime soda glass has just been published by Douglas[1], namely,

$$\eta = T\,(A'e^{B'/T} + C'e^{D'/T}), \qquad (1)$$

where A', B', C' and D' are constants, and T the absolute temperature.

I have recently shown[2] that for non-associated liquids we may write:

$$\eta\,\sqrt{v} = Ae^{B/T}, \qquad (2)$$

where v is the specific volume.

(2) differs from the well-known Andrade–Guzmán equation by the occurrence of $\sqrt{v}$ in the variable η, a difference which, although not affecting the accuracy of the equation (for within any temperature range the variation in viscosity is many times greater than the corresponding change in $\sqrt{v}$), leads to a tolerably constant value of $\eta_c\sqrt{v_c}$, the value of $\eta\sqrt{v}$ at the critical temperature.

For associated liquids, I found that the addition of a second exponential term to (2) gives an equation which is in good agreement with the experimental data:

$$\eta\sqrt{v} = Ae^{B/T} + Ce^{D/T}. \qquad (3)$$

(3) is, of course, a modification of (1) and has been fitted to the experimental results for a number of substances. A typical case is that of 2·2 dimethyl butanol I:

Temperature ° C.	5	15	25	35	45	55	65
$\eta\sqrt{v}$ calc. (η in 10^3 poise)	352 7	177 5	98·2	59·3	38·7	26 95	19 76
$\eta\sqrt{v}$ expt.	350·2	176·9	99 6	60·0	39·2	27·27	19 94

Temperature ° C.	75	85	95	105	115	125
$\eta\sqrt{v}$ calc. (η in 10^3 poise)	15·10	11·90	9·62	7·93	6·64	5·635
$\eta\sqrt{v}$ expt.	15·11	11·84	9 52	7 89	6 64	5 670

Values of the constants A, B, C (as $-\log_{10} C$) and D for a number of alcohols which are known to give a markedly non-linear relationship between $\log \eta\sqrt{v}$ and $1/T$ are tabulated below, together with the average percentage deviations between the observed and calculated values of the viscosity. The observers are indicated by references to footnotes.

Substance	B	D	A	$-\log_{10}C$	Mean % error	Viscosity range
Water[3]	1,247	3,777	0 09464	5·0652	0 2	2 84— 17·9
Ethylene glycol[4]	2,234	5,570	0·04445	6·2535	1 0	10·4 —199
Tert. butyl alcohol[5]	2,250	7,411	0·01121	9·3206	1 1	6 00— 33·5
Tert. amyl alcohol[5]	2,199	5,947	0 01351	7·3949	1·7	4 34—142
'Active' amyl alcohol[5]	2,030	3,742	0 02050	4·0044	0·5	5 05—111
Hexanol 1[6]	108 2	2,777	0 9817	2·3526	0 4	3·45— 89·2
Hexanol 2[6]	1,540	4,468	0 07927	4·9910	0·4	3 83—108
Heptanol 1[6]	1,437	3,035	0·09070	2·8233	0·3	4·50—100
2.2.dimethyl butanol 1[6]	2,319	6,452	0·01584	7·6227	0·7	4·86—321
2.methyl pentanol 5[6]	1,127	2,925	0·1120	2 6009	0·7	3·74— 90 9
2.ethyl butanol 1[6]	1,670	4,378	0·06250	4 7077	1·7	3·61—146
3.methyl pentanol 1[6]	1,094	3,088	0·1540	2·8441	0·9	3·74— 96·2
2.methyl pentanol 3[6]	1,926	5,735	0·02713	7·0086	1·8	3·15—102
3.methyl pentanol 3[6]	1,418	4,380	0 09482	4 0246	1·1	3·66— 73 4

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[1] *Nature*, **153**, 415 (1946).
[2] Thomas, *J. Chem. Soc.*, 573 (1946).
[3] "International Critical Tables."
[4] Bingham and Fornwalt, *J. Rheol.*, **1**, 372 (1930).
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[6] Hovorka, Lankelma *et al.*, *J. Amer. Chem. Soc.*, **55**, 4820 (1933); **60**, 820 (1938); **62**, 187, 1096, 2372 (1940); **63**, 1097 (1941).

The Logarithmic Transformation

In a recent communication, Dr. H. V. Musham[1] directs attention to the fact that a logarithmic transformation of a variable may not only make the distribution more normal but will often stabilize the standard deviation, that is, make it more or less independent of the mean in those cases where the standard deviation of the original variable is roughly proportional to the mean. He is, perhaps, mistaken when he suggests that the latter effect has not previously been appreciated. In cases where the logarithmic transformation is used as a preparatory step to an analysis of variance, its main purpose is to ensure that the standard deviation, as calculated from a residual sum of squares, shall be applicable to the various 'treatment' means, even when these differ considerably from each other. The lack of normality of the distribution of the residual error is not in itself of any great practical consequence.

There is yet another useful property of the logarithmic transformation which is often not appreciated. If natural logarithms are used, we have

$$y = \log x$$
$$dy = dx/x.$$

If variations in x are not too large, we may put $x = \mu$, its mean value. Then

$$dy = dx/\mu,$$

$$\therefore \text{standard deviation } (y) = \text{standard deviation } (x)/\mu = \text{coefficient of variation } (x).$$

Hence, the coefficient of variation of x is given directly by the standard deviation of $y = \log x$, which can be estimated by the usual method from

$$s = \sqrt{\{\Sigma(y-\bar{y})^2/(n-1)\}}.$$

If common instead of natural logarithms are used, the standard deviation of y must be multiplied by 2·30259 to give the coefficient of variation of x.

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[1] *Nature*, **158**, 453 (1946)

Activity of 'Vitamin A-Acid' in the Rat

It is a well-known fact that β-carotene is converted by mammals into vitamin A, which is stored in the liver. As vitamin A-acid is biologically active[1], it seemed possible that this substance might also be converted into vitamin A. To investigate this question the following experiments were carried out.

Young rats were grown on a diet freed of vitamin A. After signs of deficiency had appeared, the rats were divided into groups of five animals. From one group the vitamin A content of the livers was determined after saponification. (The vitamin A determinations were carried out by the Analytical Department using the Carr and Price reaction and the Lovibond colorimeter.) This proved to be zero. The rats of a second group each received subcutaneously 10 mgm. of vitamin A-acid as sodium salt dissolved in 2 c.c. phosphate buffer (pH 10·5). These injections caused no serious damage. After three days the vitamin A content of the livers was determined. It proved to be zero.

The rats of a third group each received subcutaneously on seven successive days 1 mgm of 'vitamin A-acid' dissolved in 0·2 c.c. of the same buffer. On the ninth day the vitamin A content of the livers was zero.

The rats of a fourth group received orally on three successive days 3 mgm. of vitamin A-acid as sodium salt dissolved in 0 3 c.c. phosphate buffer pH 10·5. On the fifth day the vitamin A content of the livers proved to be zero.

From the above experiments we may conclude that the sodium salt of vitamin A-acid, whether administered orally or subcutaneously, is not converted into vitamin A, and probably itself exerts its biological activity.

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[1] *Nature*, **157**, 190 (1946), **158**, 60 (1946) *Rec Trav Chim* **65**, 338 (1946)

Use of Water Purified by Synthetic Resin Ion-Exchange Methods for the Study of Mineral Deficiencies in Plants

An adequate supply of highly purified water is an essential requirement for the study of plant nutrition problems, particularly those relating to mineral deficiencies, when experiments are carried out on a large scale. Liebig, Vanselow and Chapman[1] in California found that tap water purified by the synthetic resin ion-exchange principle was satisfactory for maintaining healthy growth in citrus and sweet lemon without any toxic effects. They did not, however, report any experiments using demineralized water in deficiency cultures, although they published analytical results indicating that considerable removal of certain of the major and trace elements was effected by the treatment. Schroeder, Davis and Schafer[2] have recently published a note in which they conclude that demineralized tap water is unsuitable as a substitute for distilled water for boron-deficiency cultures. Using the latter, symptoms of this deficiency developed in canning beet in five weeks, whereas, in parallel cultures with the demineralized water, no symptoms were observed.

I have previously reported[3] the use of demineralized water at Long Ashton, using the 'Permutit' method, for large-scale sand culture work, using both a hard tap water and rain water, but in view of the unfavourable results obtained for boron by Schroeder *et al.*, it is of interest to refer to results obtained at Long Ashton for both boron and other nutrient elements.

In deficiency experiments with plants, the ultimate test of any point of technique must be that of biological analysis, and using such a criterion a number of indicator crops have been grown under deficiency conditions to test a demineralizing apparatus during the 1945 and 1946 seasons. The effectiveness of the technique was judged by the method of visual diagnosis, and the purity of the treated water was also checked by chemical analysis.

Using tap water, the following deficiencies were produced in acute forms: nitrogen, phosphorus, calcium, magnesium, potassium and manganese in tomato (Market King); calcium in sugar beet and hungry gap kale; iron in oats (Star); boron in cauliflower (Majestic), sugar beet and celery.

Using rain water, in extensive experiments with a large variety of crops, the following deficiencies were observed: iron in tomato, potato, sugar beet, red clover, marrowstem kale, flax, wheat, oats; manganese in tomato and globe beet; boron in tomato, potato, sugar beet, globe beet, red and alsike clover, lucerne, dwarf, broad and runner bean, pea, flax, parsnip. The severity of calcium deficiency symptoms, in crops like alsike clover, parsnip, flax and cereals, was greatly accentuated over that produced by the use of untreated rain water.

The effectiveness of the removal of specific inorganic ions depends on the total concentration of other ions present; for example, efficiency of removal of a small quantity of iron increases as the amounts of calcium and magnesium decrease. Considerable increase in efficiency, and improvement in pH reaction and sodium elimination has been obtained by the use of a secondary cation exchanger to reduce further the cation level in the water, although the anion content is not changed.

The analytical results of Liebig *et al.* do not show appreciable reduction in boron content, and experience at Long Ashton shows that boron is less readily removed than some ions; but with rain water having an initial boron content of about 0·01 p.p.m., the boron level can be reduced to as little as 0 0025 p.p.m.

The apparatus in use at present has delivered more than 1,000 gallons of purified rain water without regeneration, and the figures for iron content are representative of its efficiency: April storage rain water 0·03 p.p.m., purified 0·0017 p.p.m.; August storage rain water 0·50 p.p.m., purified 0·003 p.p.m

The use of demineralized water holds considerable possibilities for large-scale trace element research, and further experiments in this direction are in progress. Full details of technique and analyses will be published later.

This work has been carried out under the Agricultural Research Council's scheme for plant nutrition with the aid of special grants for which grateful acknowledgment is made. I wish to thank the Permutit Co., London, for their interest and helpful co-operation in the design of suitable equipment and for making the apparatus available for use in the experimental sand cultures at Long Ashton.

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Sept. 16.

[1] Liebig, G F, jun, Vanselow, A P, and Chapman, H D, *Soil Science*, **55**, 371 (1943)
[2] Schroeder, W T, Davis, J F., and Schafer, J., jun, *J Amer. Soc. Agron*, **38**, 754 (1946)
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Adsorption on Carbon of Rare Earth Organic Complexes

Although Botti[1] studied the adsorption on activated carbon of members of the rare earth group, and Croatta[2] and others[3] have examined chromatographical methods of their separation, the investigations of these workers have been confined to rare earth ions as such.

The adsorption on charcoal of organic compounds is, as is well known, much higher than that of inorganic ions, and consequently it was considered that an examination of the adsorption of rare earth organic complexes might yield interesting results, particularly if such complexes were coloured.

Several colour tests for the rare earths, individually and collectively, have been variously proposed; but for the initial work indicated here the violet *p*-phenetidine cerium complex of Wenger, Rusconi and Duckert[4] was employed. To a solution containing a few milligrams of cerium in the tetravalent state, saturated aqueous *p*-phenetidine was added and a small amount of decolorizing charcoal shaken with the violet-coloured solution produced; adsorption of the colour was immediate and complete, and after filtration the complex could be recovered from the charcoal by extraction with chloroform. To obtain the data indicated in the table below, the chloroformic extract was evaporated to dryness, ignited, and the residual oxide weighed.

Cerium oxide taken (mgm.)	Carbon used	Cerium oxide recovered (mgm.)
3·15	0·1 gm	3·0
6·30	0·1 ,,	6·1
9·45	0·1 ,,	9·2
12·60	0·1 ,,	12·4
10 gm. La_2O_3 + 0·1% CeO_2	0·1 ,,	9·5
Control 10·0	0·1 ,,	nil

The applicability of this separation only being to the removal of small amounts of cerium from solution, a lanthanum nitrate solution containing 0·1 per cent Ce was treated by this method for removal of the cerium. Although actual recovery by this method is not exceptionally near theoretical, the efficiency as a method of removing traces of cerium occurring as impurities is excellent, as spectrographic examination showed complete absence of that element in the aqueous filtrates obtained in the first instances and in the lanthanum oxide produced in the final cases. As Botti has shown that adsorption of the rare earths on charcoal, although small, does occur, a control experiment was conducted in which the adsorption of tetravalent cerium ion was determined in the absence of the organic complex.

A more comprehensive study of this separation has been prepared, and will be published elsewhere, in which the efficiency of this procedure is confirmed and the application of the technique to other rare earths indicated.

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[1] *Atti X° Congr. Intern. Chim.*, 3, 406 (1939).
[2] *Ricerca Sci.*, 12, 157 (1941).
[3] Erametso *et al.*, *Chem. Zentr.*, 1, 2387 (1943); 1, 2568 (1942).
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Adenosine Triphosphate in Mammalian Spermatozoa

THE presence of adenosine triphosphoric acid (that is, of readily hydrolysable phosphorus) in mammalian spermatozoa has been established by Ivanov and Kanygina[1] and by Lardy, Hansen and Phillips[2].

According to the findings of Ivanov and Kanygina[1] the content of adenosine triphosphate in sheep spermatozoa, obtained from the epididymis, varies within the limits of 12–30 mgm. of adenosine triphosphate phosphorus per 100 gm. of the contents of the cauda epididymis. The adenosine triphosphate content decreases under anaerobic conditions parallel with the decrease of motility of the spermatozoa. If aerobic conditions are provided for, or if glucose is added, the adenosine triphosphate content of the sperm cells returns to its initial value; simultaneously the spermatozoa resume their movements. Mann[3] has isolated adenosine triphosphate from sheep sperm and determined a number of constants characterizing this preparation.

We have studied the biological effect produced by adenosine triphosphate isolated from spermatozoa on actomyosin threads prepared according to Szent-Györgyi[4]. It was found that adenosine triphosphate isolated from pig spermatozoa provokes a marked contraction (by 40–60 per cent) of the actomyosin thread in a saline medium. It follows that adenosine triphosphate from sperm cells seems not to differ, in respect of its ability to react with actomyosin in the presence of potassium and magnesium salts, from adenosine triphosphate isolated from muscle.

It should be noted, however, that if a solution of muscle adenosine triphosphate is added to spermatozoa obtained from the epididymis which have lost their motility under anaerobic conditions, no resumption of the movements of the spermatozoa is observed. The last-mentioned experiments were usually made in the presence of monobromacetate, which does not interfere with the dephosphorylation of adenosine triphosphate but blocks the anaerobic decomposition of carbohydrates with the formation of lactic acid.

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[1] Ivanov, I. I., and Kanygina, K. Y., *C.R. Acad. Sci. U.S.S.R.*, 50, 361 (1945). See also Ivanov, I. I., *Human Fertility*, 10, 33 (1945); *Progress of Modern Biology*, 13, 627 (1943); 21, 99 (1945).
[2] Lardy, H. A., Hansen, R. G., and Phillips, P. H., *Arch. Biochem.*, 6, 41 (1945).
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Action of Prostatic Secretion on the Motility and Metabolism of Spermatozoa

WE know[1,2] that the secretion of the prostate possesses a pronounced ability to activate the motility of spermatozoa isolated from the epididymis. The effect of the prostatic secretion of the dog on the motion and respiration of canine spermatozoa has been studied by Ivanov[3]. We have now investigated the effect of the prostatic secretion of the dog on the motion of spermatozoa both under aerobic and anaerobic conditions.

It was shown that prostatic secretion activates markedly the motility of spermatozoa both in the case of a free access of oxygen and under anaerobic conditions (in the presence of cyanide). In the latter case, however, to obtain a prolonged effect, it is necessary to add to the sperm some carbohydrate which can be utilized as a substrate for glycolysis. Consequently, prostatic secretion activates to a high degree the utilization by spermatozoa of the energy of both aerobic and anaerobic energy-producing processes. This capacity of the secretion is lost by it after it has been heated to 100° C. This effect of the prostatic secretion is species specific. Thus, for example, the secretion of the prostate of a dog is unable to activate the movements of bull or sheep spermatozoa.

We are at present attempting to find out whether prostatic secretion contains a protein capable of activating the contractile protein of the spermatozoan tail.

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[1] Ivanov, I I., *Human Fertility*, 10, No. 2, 33 (1945)
[2] Huggins, *Phys Rev*, 25, No 2, 281 (1945)
[3] Ivanov, I I., *C R Soc Biol*, 103, 57 (1930).

Inhibiting Action of Fluorophosphonates on Cholinesterase

IN connexion with the interesting report[1] by Dr. M. Dixon and Dr. D. M. Needham on "Biochemical Research on Chemical Warfare Agents", we should like to mention that the first observations on the cholinesterase-inhibiting action of fluorophosphonates were made in 1941 [2]. At that time the dimethyl and diethyl fluorophosphonates only were known; these compounds are somewhat less toxic than the di-isopropyl fluorophosphonate, but otherwise have similar effects. The long-lasting constriction of the pupil produced by dimethyl fluorophosphonate suggested a mode of action like that of eserine, and we found that, like eserine, it strongly inhibited the cholinesterase activity of human plasma. When the more toxic di-isopropyl fluorophosphonate was prepared, we found that it had a more potent inhibiting action on cholinesterase[3].

An account of these early observations will be published in the *Journal of Pharmacology*.

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[1] *Nature*, 158, 432 (1946).
[2] Report XZ.71 to the Min of Supply, October 1941
[3] Report XZ.111 to the Min of Supply, November 1942.

A Medium for Investigating the Breakdown of Pectin by Bacteria

DURING the course of an investigation on the bacteria associated with the rotting of potatoes in storage, carried out on behalf of the Agricultural Research Council, a large number of isolates was tested for ability to break down pectin.

Previous investigators have used one of the following methods in the examination of the breakdown of pectin: (1) observation of the growth of an organism in a medium with pectin as the sole source of carbon; (2) testing of enzyme preparations of cultures for ability to cause loss of coherence in strips of plant tissue, or changes in viscosity of a pectin solution; (3) measurement of the rate of utilization of a particular pectic substrate by progressive chemical analysis. While the above methods would be satisfactory, it seemed that a more suitable method, for a rapid qualitative test, would be to grow the organisms on a pectin gel. Organisms which were able to break down pectin would cause liquefaction of the medium. In the past, it has only been possible to prepare pectin gels with high sugar concentrations, and under acid or alkaline conditions[1] which would not support the growth of bacteria. Low methoxylated pectin gels[2,3] can now be prepared with a low sugar content and with an increased range of pH, and it is possible that they might be used in the present investigation, but they have not been available to me.

Through the courtesy of the A.S.P. Chemical Co Ltd., of Gerrards Cross, a sodium pectate powder was obtained which would form a gel at a neutral pH and in the absence of sugar. The medium is prepared as follows: a basal solution is made up containing $NH_4H_2PO_4$ 1 gm., KCl 0·2 gm. and $MgSO_4$ 0 2 gm. per litre of distilled water. To this solution is added 50 ml. per litre of buffer solution (McIlvaine's phosphate-citrate buffer, 0·2M NaH_2PO_4, 0·1M citric acid). The mixture is heated to 70° C. and sufficient of the powder added to give a 1 per cent concentration. The mixture is further heated almost to boiling and held at this temperature for about five minutes. From the time of the addition of the pectate powder, the mixture must be thoroughly stirred. It has been found helpful to add Bromo Thymol-Blue to the medium as an indicator. The medium is tubed and sterilized by bringing momentarily to 120° C. in an autoclave, turning off the gas and allowing to cool. This method of sterilization[4] reduces breakdown of the pectate.

The setting of the medium is brought about by a certain concentration of calcium ions (approximately 3·2 per cent of the powder), which convert some of the sodium pectate to calcium pectate on cooling. The addition of a small proportion of a 10 per cent solution of calcium chloride increases the structural viscosity of the gel.

Tubes, inoculated by needle stabs from broth cultures, of *Bact. phytophthorum*, *B. carotovorum*, *B. aroideæ* and *Bacillus polymyxa* showed slight liquefaction after two days at 25° C., and the liquefaction was almost complete after a week. *Bs. subtilis* produced a slight liquefaction after four days. *Bact. ærogenes*, *Bs. mesentericus* and *Pseudomonas fluorescens* did not liquefy the medium after twenty days. No extensive examination of cultures of fungi has been undertaken; but *Botrytis cinerea* and *Sclerotinia minor* produce a liquefaction of the medium.

Liquefaction of this medium indicates the splitting of the pectate unit and is not necessarily the same as loss of coherence in plant tissues. Comparative tests, however, have shown that liquefaction of a pectate gel and loss of coherence of plant tissue appear to be correlated.

I am much indebted to Dr. W. J. Dowson and Dr. N. A. Burges for their advice in this work. This brief account is published as it is considered that the medium may have applications in other directions.

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Oct. 1.

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Mitotic Disturbances Induced in Yeast by Chemicals, and their Significance for the Interpretation of the Normal Chromosome Conditions of Yeast

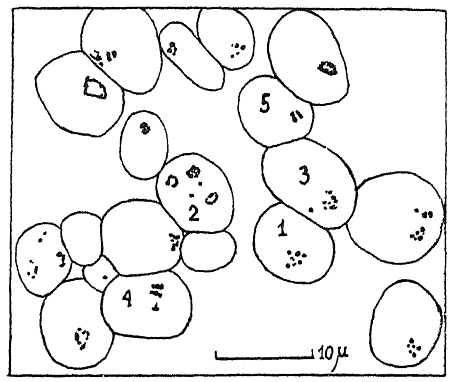
THE camphor reaction of yeast, described by Bauch[1], was interpreted by me[2] as a narcosis affecting the normal growth of the yeast cell. Instead of budding normally, the yeast, under the influence of many chemicals of the same type as the narcotics, grows out into associations of cells, which show an irregular, tube-like, bottle-shaped or vesicular form. Their cell volume is often enlarged In 1938 and 1939, Segal[3] induced this reaction by treatment with the higher aliphatic alcohols and fusel oil. The so-called involution forms of yeast, often observed in ageing cultures in connexion with the autolysis, seems to be a phenomenon of the same nature, the yeast cells narcotizing themselves with their own metabolic products.

Segal noticed the occurrence of abnormal nuclei in yeast cells treated with the higher alcohols No detailed study of the nuclear conditions of the 'camphor cells' has been made, however, although supposed chromosome-doubled types of yeast have been produced by chemical treatments several times[1,4,5]. In the present communication a few data will be given concerning the nuclear behaviour of 'camphor cells' induced by camphor, butyric alcohol and benzene.

During the first days of treatment, most nuclei in the 'camphor cells' divide normally, each daughter cell obtaining one normally shaped nucleus. After a somewhat longer treatment, certain mitotic disturbances appear, and after a fortnight there may be a large number in some slides. The accompanying photomicrograph, which has been made from a Feulgen-stained slide of cells treated for sixteen days with 0·012 mol. benzene, shows some typical deviations from normal mitosis. In cell 1 a fairly normal metaphase is seen in polar view. About ten separate bodies may be counted, six of them being larger. In cell 2 three nuclei are present, and in addition two solitary bodies which I interpret as single chromosomes. This configuration is suggestive of the action of a multipolar spindle. 3 and 4 show instances of one larger nucleus and one small body outside the nucleus, presumably one vagabond chromosome. In other cases I have found pairs of chromosomes lying free in the plasma, single chromosomes having evidently divided in their abnormal position.

The mitotic disturbances here described are of special interest, since they furnish an opportunity to estimate the size of single yeast chromosomes, which is seldom possible in untreated cells, where the chromosomes usually appear in dense groups; and it is found that the chromosome size varies from $0·1\,\mu$ to, perhaps, $0·5\,\mu$. Thus, the chromosome size lies near the limit of what can be seen in the microscope.

In my best fixations of untreated yeast I have found the nuclei to contain a number of distinct bodies of a size similar to that of single chromosomes of these treated cells. At metaphase these bodies may be seen clearly and have the same appearance as cell 1 of the present picture. They are often distributed on a hollow spindle. At normal anaphase their tendency to stick together may easily give an impression of one or two bodies, just as has happened in cell 5 of the reproduction. In my opinion this is the cause



Saccharomyces cerevisiæ TREATED FOR SIXTEEN DAYS WITH 0·012 MOL. BENZENE, 1, NORMAL METAPHASE, 2, EFFECT OF MULTIPOLAR SPINDLE, 3, 4, VAGABOND CHROMOSOMES, 5, LUMPING OF CHROMOSOMES INTO TWO BODIES × 1,200

both of the assumption of amitosis in yeast and of the low chromosome number reported by many workers (for example, Badian[6], Sinoto and Yuasa[7]). After having been able to study the size of single chromosomes in treated yeast, I do not doubt that the normal chromosome number of yeast is higher Ten separate elements are often counted in untreated material, and it is quite probable that several very small chromosomes are then concealed. I accordingly consider ten a minimum number. Neither can I agree with Lindegren[8] that the Feulgen-positive constituent of the yeast cell is a centriole without further interior organisation.

The nuclear disturbances of the 'camphor cells' of yeast are evidently not identical with full colchicine-mitosis of higher plants. Even after long treatment, the spindle apparatus functions at least partially. The disturbances observed may very well give rise to cells with altered chromosome number; in fact, cells with doubled number have been actually seen in my slides. If a similar condition occurs also in the normally occurring involution forms of ageing cultures, it may be important not to use old cultures as mother cultures in practical brewery.

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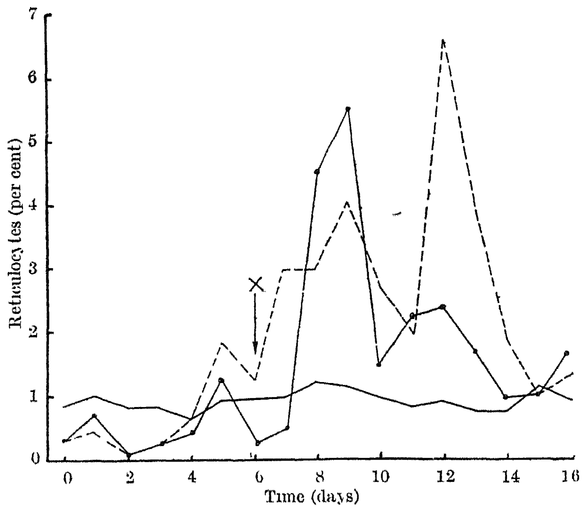
Reticulocytosis following the Administration of Thymine to Splenectomized Rabbits

Jacobson and Williams[1,2] have reported that splenectomized rabbits show a reticulocytosis after intramuscular injections of liver extract, and have suggested that this observation could form the basis for a method of bio-assay of liver extracts.

Following Jacobson's report, we have carried out a number of experiments on a series of eighteen splenectomized rabbits and have confirmed, qualitatively, the response of these animals to an injection of liver extract. We are not in a position at this stage to comment on the quantitative nature of the response, except as noted below. The appearance of a series of papers by Spies and his collaborators[3,4,5,6] on the value of thymine (5-methyl uracil) in the treatment of sprue and pernicious anæmia suggested the investigation of the action of thymine in splenectomized rabbits.

We have now shown that intramuscular and intravenous injections of thymine produce a marked reticulocytosis in these animals. With intramuscular injections, a latent period of 2–4 days is usually observed, but using the intravenous route, a more rapid response is obtained. This effect is marked in doses varying from 50 mgm. to 250 mgm., and was still apparent in one animal on a dose of 5 mgm.

The smaller doses of thymine were usually given in warm aqueous solution (1–3 mgm./ml.) and the larger doses in suspension in the same medium. The accompanying graph shows the result of administering 100 mgm. and 20 mgm. to splenectomized rabbits. It also shows the absence of effect due to the administration of distilled water alone



----, 100 mgm. thymine intramuscularly, ——, 5 ml distilled water intramuscularly; —o—, 20 mgm thymine intravenously Injections were made at X

All the rabbits used in these experiments showed a normal reticulocyte level of 1·0–2·0 per cent, and a response was considered positive only if a level of 2·0–3·0 per cent or more was observed. Two or three weeks prior to being treated with thymine, each rabbit was given an intramuscular injection of 1·0 ml. of purified liver extract ('Examen'), and any animal not showing a positive response was rejected from further experimental work. Although the responses of different rabbits to an equal dose of thymine showed considerable variation, it was observed that a dose of 100 mgm. or more of thymine usually resulted in a higher reticulocyte peak than that obtained with 1 0 ml. of 'Examen'.

The foregoing results supply further evidence that splenectomized rabbits respond to materials active in pernicious anæmia, and the fact that the height of the reticulocyte peak appears to run roughly parallel with the size of the dose of thymine suggests that the response may be more or less quantitative. The results also lend support to the view that thymine or some substance of similar structure may play an important part in hæmopoiesis.

Further work is in progress with related compounds to determine whether they have an action similar to that of thymine.

We are indebted to Dr. J. F. Martin for supplies of thymine and to the directors of Genatosan, Ltd., for permission to publish this note.

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Carbohydrate Metabolism in Alloxan-diabetic Rats

Mering and Minkowski[1] and also Hédon[2] have already found that the glycogen content of the liver and of the skeletal muscles, during experimental pancreas-diabetes, is being very much decreased. This was always confirmed by later authors and led to various hypotheses concerning the action of insulin on carbohydrate metabolism. By means of their mode of experimental procedure, Major and Mann[3] were able to show that the formation of glycogen in pancreatectomized dogs is not suppressed in the case of permanent glucose infusion. Concerning the glycogen content of liver and skeletal muscles, Lackey, Bunde, Gill and Harris[4] obtained the same results in alloxan-diabetic rats as Mering and Minkowski in pancreatectomized dogs. The investigations of Laszt[5] and Laszt and Vogel[6] on the carbohydrate metabolism in alloxan-diabetic rats make it probable that the formation of glycogen cannot be lowered. We were, therefore, induced to verify this point. The rats were made diabetic by the method suggested by Laszt[5]. There was no steatosis of the liver to be observed, neither macroscopically nor microscopically. This fact is of importance, as the formation of glycogen and its deposition is suppressed in fatty liver[7].

As the accompanying table shows (average rates), the glycogen content of the liver after 24 hr. fasting is higher in alloxan-diabetic rats than in normal ones, whereas the glycogen content of the muscles is lower. One hour after glucose feeding (1 gm.) the liver glycogen, as well as the

	Liver				Skeletal muscle
	Glycogen (%)	In-organic P (mgm. %)	Total acid soluble P (mgm %)	Organic P. (mgm %)	Glycogen (%)
Normal animals					
After 24 hr. fasting	0 136	31 70	94 70	63 00	0 328
1 hr. after 1 gm glucose feeding	0 500	22 12	87 87	67 75	0 380
Diabetic animals					
After 24 hr. fasting	0 913	28 40	95 00	66 60	0 247
1 hr after 1 gm. glucose feeding	1 729	21 50	97 75	76 25	0 390
Diab.-adrenal-ectomized animals					
After 24 hr. fasting	0 058	46 62	100 65	54·03	0 266
1 hr after 1 gm glucose feeding	0 296	33 10	93 30	60 20	0 259

skeletal muscle glycogen, rise more in diabetic animals than in normal ones. Alloxan-diabetic rats in which glycosuria and hyperglycæmia have been completely suppressed by adrenalectomy show, when young and when fed, a lower glycogen content of liver as well as of skeletal muscle than normal ones. Further, the organic phosphate in the liver was also higher in alloxan-diabetic rats than in normal rats.

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Observations on the Moth *Plusia gamma* in Denmark in 1946

THIS year the noctuid *Plusia gamma* has been more abundant in Denmark than at any time since 1905. It is likely that the swarms arrived here in June; the first report of damage caused by the larvæ came from the southern part of Denmark, and was followed by similar reports from more northern parts, thus closely corresponding to the seasonal progression recorded in England[1]. The adults appeared about August 1.

The main results of the observations in the field, confirmed by experiments in the laboratory, are as follows. *Plusia gamma* has two different activity patterns, one for seeking food on plants, another one for migrating. The first is correlated with the temperature, maximum activity being found at temperatures between 25° and 30° C., with a lower limit at 18–20° C.; accordingly, the feeding takes place in the day-time, especially on bright and warm days.

We have only observed the migrating activity during the night. The temperature limit is much lower, about 12°–14° C. The moths were not found to feed during migration, except on a few very warm nights. Migratory individuals seem to be less attracted by light than other moths. The flight takes place at heights of 5–20 m above the ground, and the direction of the flight is very nearly the same for all individuals observed during a certain period. But, unlike previous investigators[2,3], we have found that the migrations are in the direction of the wind. This is not only the result of general observations, but out of 440 individuals actually counted during ten observations lasting for 10 minutes, 73 per cent moved exactly in the main direction of the wind and only 6 per cent deviated by more than 45° from this direction. The directions of the wind were north, north-west, west, south-east and east. These observations were made by means of a searchlight.

In Denmark, sunset in August is at about 8 p.m. (M.E.T., one hour after G.M.T.); the migrations start one or two hours later, and last for about three–four hours, with a maximum in the hour before midnight.

Towards the end of August, the number of individuals decreased. Copulation was never observed, and only about one per thousand of the females had developed eggs in the ovaries. As no evidence of a return flight has so far been recorded from Denmark, it is possible that this generation will die out entirely.

A detailed report of the observations and experiments will appear in the near future in *Entomologiske Meddelelser* (Copenhagen).

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Segmentation of the Spinal Cord in the Human Embryo

VARYING statements regarding segmentation of human spinal cord have been made by different writers. They range from "No definite segmentation can, however, be effectively demonstrated. The obvious segmentation of the tube is through the nerve roots which arise in regular sequence from its walls"[1] of Paterson to that of Sir Arthur Keith, who states that "Dr. Watt observed in a human embryo in which there are 18 body somites that 11 segments were to be noted in the spinal cord"[2].

In the course of study of "The Neuraxis in South Indian Fœtuses and Neonati", clear segmentation of the spinal cord has been noted in some specimens. Actual photographs of two embryos are reproduced here. The first one is that of an embryo the C.R. length of which is 5·1 cm. Its age will be between

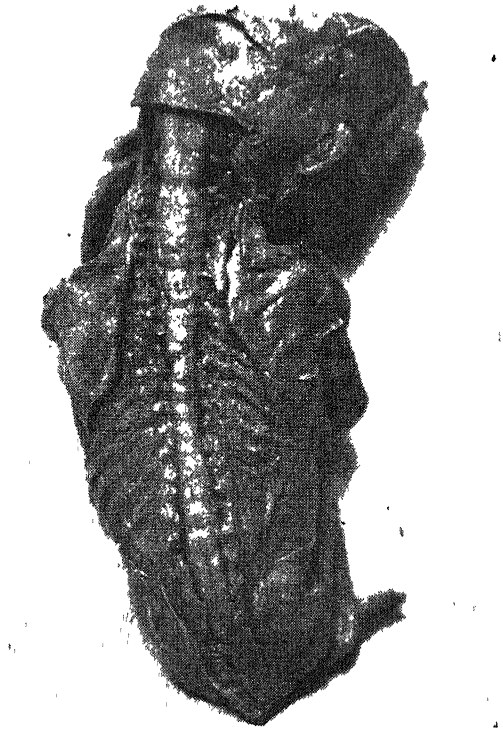

Fig 1

ten and eleven weeks. The spinal cord shows twenty-five segments ; and cervical and lumbar enlargements are also made out. The second one is that of an embryo the C.R. length of which is 6 2 cm. Its age

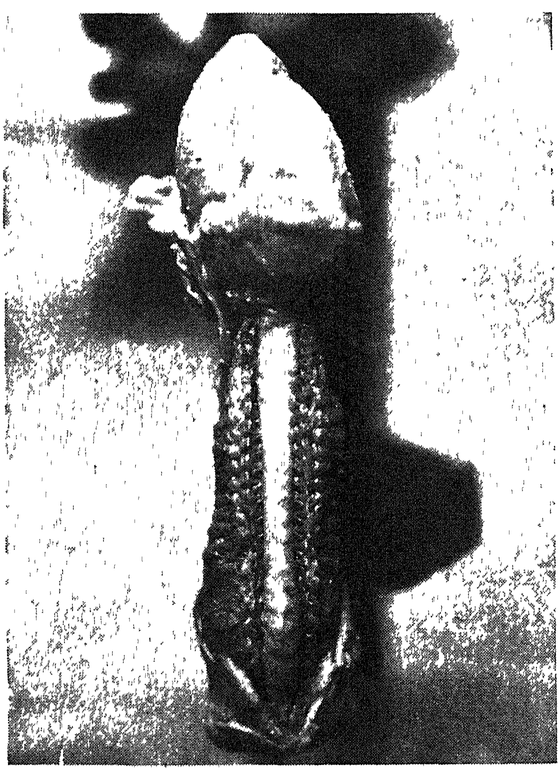

Fig. 2

will be between eleven and twelve weeks. It is slightly older than the first one. The spinal cord shows clearly the cervical and lumbar enlargements and twenty-six segments. That the segmentation is a regular one and not caused by pressure of the vertebræ can be seen by the position of the nerves that emerge out from each segment (Fig. 2).

Further work is in progress.

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Blood Groups of Burmese

THERE does not appear to be any record in the literature of blood-group tests made on Burmese subjects ; we therefore took a recent opportunity of testing the blood of a number of subjects with regard to *ABO* and *Rh* groups. We had intended to group many hundreds, but owing to unforeseen circumstances had to abandon the work after only about two hundred persons had been tested However, in view of the absence of other published data and the present interest in the racial distribution of the *Rh* factor, we are publishing this brief report on the results.

229 subjects were tested against anti-*A*, anti-*B* and anti-*Rh* sera. The anti-*Rh* serum was a potent sample that had been dried in small ampoules by Dr. R. I. N. Greaves. A sample has recently been submitted to Dr. R. R. Race, who reports that the serum contains anti-*C* + anti-*D*[1] agglutinins with a very little anti-*Du*[2].

The results were as follows :

Total no. tested	*O*	*A*	*B*	*AB*	*Rh*+	*Rh*−
229	83	60	68	18	229	0
	(36·2%)	(26 2%)	(29·7%)	(7·9%)	(100%)	nil

A few bloods failed to react with the anti-*Rh* serum on first testing, but on being re-tested with the same serum they gave positive results. These same few bloods were also tested against at least one other dried anti-*Rh* serum, and all gave positive results. All these anti-*Rh* sera gave consistently clear-cut negative reactions with known *Rh*-negative cells.

Of the 229 subjects tested, 155 claimed to be 'pure Burmese' (Anglo-Burmese and Anglo-Indian-Burmese were excluded), 57 were Karens, 13 Chins and the remaining 4 Kachins.

The absence (or certainly very low incidence) of the *Rh*-negative type in Burmese is not unexpected in view of previous reports[3] of a very low incidence in Chinese.

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RESEARCH ITEMS

Choline and Phospholipid Synthesis

THE action of dietary choline in preventing and curing certain types of fatty liver in rats is well known. There is now considerable evidence, reviewed by E. W. McHenry and J. M. Patterson (*Phys. Rev.*, 24, 128; 1944), that this 'lipotropic' action is due to the part which choline plays in the formation of phospholipids. It is believed that fat is normally transported from the liver in the form of phospholipid and that choline, being a constituent of certain phospholipids, is necessary for their synthesis and therefore for fat transport. In choline deficiency, the normal transport of fat from the liver is interrupted and fat accumulates therein; while administration of choline can accelerate the removal of fat from various types of experimentally produced fatty livers. More recently, W. H. Griffith and N. J. Wade (*Proc. Soc. Exp. Biol. Med.*, 41, 188; 1939) described another result of choline deficiency, hæmorrhagic degeneration of the kidneys. This lesion was produced much more readily in young growing rats than in adults. J. M. Patterson and E. W. McHenry (*J. Biol. Chem.*, **145**, 207; 1942) found in such cases that the phospholipid content of the kidneys (both percentage and absolute) was below normal and suggested that the lesion resulted from a failure of phospholipid synthesis at a period when phospholipid was required as a protoplasmic constituent for the development of the growing kidney. J. M. Patterson, N. B. Keevil and E. W. McHenry (*J. Biol. Chem.*, **153**, 489; 1944), using radioactive phosphorus, have shown that the rate of phospholipid turnover in the rat's kidney is greatest at the time (sixth day of life) when the kidney is most susceptible to choline deficiency, and that the turnover is greatly reduced in choline-deficient animals. It seems, therefore, that both the liver and kidney lesions of choline deficiency can be ascribed to a failure of phospholipid synthesis.

Control of Pear Midge

S. H. Bennett and H. G. H. Kearns (*J. Pom. and Hort. Sci.*, 22, 38; 1946) report the successful control of *Contarinia pyrivora* by the application of tar oil and dinitro-orthocresol washes to the soil. The larvæ pupate in the surface soil and the midges emerge in the spring to lay their eggs on the flower buds and open flowers. On hatching, the larvæ bore into the developing fruitlets, which become malformed and fall to the ground. Some control has been effected hitherto by repeated cultivations of arable soil after the fruit has fallen, by digging calcium cyanide into the soil, or by nicotine washes applied to the blossom when the midges are on the wing. Trials were made with 3 per cent high boiling neutral tar oil, and 0·1 per cent D.N.C. with 5 per cent petroleum oil, sprayed on the soil at low pressure, both as sulphite lye emulsions. A plantation of Williams' Bon Chrétien and Fertility pear trees was used and the treatments randomized to find the effects of the washes when applied at the time of bud burst (March 1, 1944) and 4–5 days before the 'white bud' stage (March 27, 1944) respectively. 900–1,200 gallons of wash per acre were applied over the surface, the top soil being dry enough to absorb it. Examination of random samples of fruitlets and comparison of crop weights at picking time showed that a high degree of control was obtained. No significant differences were obtained between the two washes or the time of application. With an infestation of 64 per cent of fruitlets on the control plots, the treatments gave from 46 to 101 per cent increase in the fruits harvested, and 31 to 53 per cent increase in the crop weights.

Genetics and Plant Breeding

D. U. GERSTEL (*J. Hered.*, 36, 197; 1945) shows that by back-crossing *Nicotiana tabacum* ($n = 24$) $\times$ *N. glutinosa* ($n = 12$) with *N. tabacum*, true-breeding lines with 25 and 26 pairs of chromosomes occur in the progeny. The extra chromosomes which are derived from *N. glutinosa* carry genes which may be useful in tobacco. For example, resistance to mosaic disease was incorporated in the new lines. A general account is given of single chromosome additions in evolution.

Pests of Cotoneaster

G. FOX WILSON has described nine insect pests of *Cotoneaster horizontalis* (*J. Roy. Hort. Soc.*, **70**, Pt. 9; Sept. 1945) Woolly aphis, and peach or European brown scale, *Lecanium corni*, are two pests already known on fruit trees. The web-spinning Tineid caterpillar, *Scythropia cratægella*, is usually an inhabitant of hawthorn bushes, but is increasing on *Cotoneaster*. It can be controlled by D.D.T. dusts and sprays. The Pyralid moth, *Eurhodope suavella*, also lives in silken galleries. It can be controlled by nicotine dusts in warm days of autumn and spring, while arsenical washes afford preventive treatment. The four major pests here mentioned appear to be most prevalent in the south-eastern counties of England.

Dry Rot of Potatoes

Phytophthora infestans and *Fusarium cœruleum* are the principal causes of fungal wastage of potatoes in clamps, but a recent survey has shown that *Fusarium avenaceum* also causes loss, especially in the varieties King Edward and Doon Star (F. Joan Moore, *Ann. Appl. Biol.*, 32, 304; 1945). A comparison of the two species of *Fusarium* showed that *F. avenaceum* caused most rotting at 20–25° C., and in conditions of high humidity, while *F. cœruleum* caused maximum loss at 15° C. and was less sensitive to low humidities; it was noted that the more susceptible the potato variety the higher was the optimum temperature for both species of *Fusarium*. Rotting was much more severe in clamps than in stores or in open trays held at the same temperature. This is apparently due to the higher humidity obtaining in the clamp; the amount of rotting is little affected by volatile excretions from the tubers.

Recession of Glaciers

IN a paper on researches on snow and ice, 1918–40, in the *Geographical Journal* of January–February, Prof. H. W. Ahlman outlines his contention that a climatological improvement in arctic latitudes began slowly in the middle of the nineteenth century and has increased rapidly in recent decades. His investigation on certain Norwegian glaciers shows that from being stationary they have reached a state of retreat and, if the rate of retreat continues, several will disappear in a few more decades. Work in west Spitsbergen and in North-East Land again showed that ablation exceeded accumulation. On Iceland glaciers comparable results were obtained. Lastly, in North-East Greenland regression was noted and, as elsewhere, at an increasing rate. Prof. Ahlman points also to the results of Russian researches north of Siberia, which indicate a vast reduction since 1924 of the sea area covered with pack-ice, a reduction in the average thickness of floes, an increase in temperature of the Kara and other seas, and a northward shift of the southern limit of permanently frozen ground. The meteorological causes of these changes lie in increased flow of warm air to the regions around the North Atlantic and the northward movement of the Icelandic low-pressure area. Prof. Ahlman stresses the need of comparable quantitative researches in the Antarctic and elsewhere.

Space Charge in the Magnetron

THE method employed by L. Page and N. I. Adams, jun. (*Phys. Rev.*, **68**, 126, 1945) to solve the space charge equation of the cylindrical diode has been applied by the same authors to solve the similar equation for the plane magnetron, consisting of two infinite parallel plane electrodes (*Phys. Rev.*, **69**, 492; 1946), and for the cylindrical magnetron, consisting of two coaxial cylindrical electrodes (*Phys. Rev.*, **69**, 494; 1946) The relationship between the current and the magnetic field is determined in both cases, as also the effect of the magnetic field on the distribution of potential and charge. An interesting feature of the plane magnetron, as shown by one of the curves, is that the current decreases only slightly with increasing magnetic field strength until quite close to the cut-off. The corresponding curve for the cylindrical magnetron is in accord with A. W. Hull's experimental values (*Phys. Rev.*, **18**, 31; 1921).

Telephone Interference Arising from Power Systems

IN a recently published paper (*J. Inst. Elec. Eng.*, **93**, Part 1, No. 66, June 1946), Messrs. P. B. Frost and E. F. H. Gould review the investigations on telephone interference which have been carried out in Great Britain between 1934 and 1944. Under the heading of electromagnetic induction at fundamental frequency, they discuss the precautionary measures available for power and telephone systems to avoid damage to equipment and injury to personnel from high induced voltages, and under interference at audio-frequency the serious effects which may arise from faulty power lines which are maintained in operation through the use of arc-suppression coils, and the possibilities of interference from power lines supplying large rectifier units. The paper enumerates the conditions under which it is permissible to employ multiple earthing in high-voltage systems, and gives evidence to show that the inter-connexion of low-voltage systems, each earthed at one point, is unlikely to cause interference. Recent apparatus developments affecting the problem, such as gas discharge tubes, noise-eliminating filters and noise-measuring instruments, are reviewed. The paper is supported by a lengthy discussion, several contributors to which emphasize the need for closer co-operation between the power supply undertakings and the telephone authorities, particularly in respect of new installations.

Raman Spectra of Mixed Crystals

SODIUM and potassium nitrates form a continuous series of mixed crystals above 130° when the two lattices unite to form a unique lattice. M. Kanaka Raju (*Proc. Indian Acad. Sci.*, **22A**, 150; 1945) has examined the Raman spectra of this system and finds frequency shifts which are regarded as corresponding with the lattice and with internal oscillations. With mixed crystals containing 25–75 per cent of potassium nitrate, there was a gradual change of frequency from that of pure sodium nitrate to that of pure potassium nitrate, and this fact, and the result that there is a unique line representing the total symmetric vibration in the mixed crystals (a mixture of the same composition showing the two lines of $NaNO_3$ and KNO_3 separately), confirm the formation of a unique lattice in the mixed crystal, the vicarious elements replacing one another atom for atom. This result is in agreement with many other investigations on mixed crystals and confirms the structure suggested for them by Vegard.

Purification of Benzene and Toluene

THE separation of thiophene and methylthiophene from benzene and toluene is not easy, and the usual methods are either tedious, or expensive and unsuitable for large amounts. J. Bougault, E. Cattelain, and P. Chabrier have described in a paper only recently available in Britain (*Bull. Soc. Chim.*, **7**, 780; 1940) a very simple process by which large amounts of the two hydrocarbons can be freed from thiophene and its derivatives so as to give no indophenene reaction. The liquid is shaken for a short time at the ordinary temperature with Raney nickel, previously washed with alcohol and ether. The preparation of the nickel was described by the same authors in an earlier paper (*Bull. Soc. Chim.*, **5**, 1699; 1938). In another paper (*Bull. Soc. Chim.*, **7**, 781; 1940) they show that Raney nickel when introduced into solutions or suspensions of many inorganic and organic sulphur compounds leads to an evolution of hydrogen, and the sulphur is completely removed in combination with nickel as sulphide. Tetrathionate and thiosulphate are rapidly converted into sulphite, and the latter then slowly converted into alkali hydroxide. Carbon disulphide in alcohol evolves a mixture of hydrogen and methane. Raney nickel is thus a valuable desulphurizing agent.

Synthesis of Methanol

THE reactions of hydrogen and carbon monoxide over a great range of experimental conditions have been studied, and one of the products is methanol (methyl alcohol, CH_3OH). The reactions of hydrogen and carbon dioxide have received little attention. V. N. Ipatieff and G. S. Monroe (*J. Amer. Chem Soc.*, **67**, 2168; 1945) have studied this latter reaction in presence of copper-alumina catalysts over a temperature range of 282–487° and a pressure range of 117–410 atm. Copper and alumina separately had no catalytic effect. The most active catalyst had a copper content of 8–28 per cent and gave conversions of 94 per cent at 410 atm. and 285°. Similar experiments with carbon monoxide and hydrogen gave much smaller conversions of 39–43 per cent, with as much as 15 per cent and 41 per cent of the carbon monoxide charge reacting to give methane and dimethyl ether, respectively. When carbon dioxide was added to the carbon monoxide in the mole ratio $CO : CO_2 = 3{\cdot}1 : 1{\cdot}0$, the methanol conversion was raised to 64 per cent and the formation of dimethyl ether reduced to about 1 per cent. Other experiments indicate that the reaction with carbon dioxide and hydrogen follows two paths: after reduction to formaldehyde, part of the methanol is formed by direct hydrogenation of formaldehyde and part by a Cannizzaro reaction.

TEMPERATURE RADIATION FROM THE QUIET SUN IN THE RADIO SPECTRUM

By Dr. D. F. MARTYN
Commonwealth Observatory, Canberra

THE radio-frequency emissivity of the sun considered as a black body is proportional to $T\lambda^{-2}$ per unit frequency increment, where T is the temperature of the radiating region, and λ is the wave-length of the radiation. The sensitivity of radio equipment is now such that it is possible to detect this radiation on the shorter wave-lengths in the radio spectrum. In particular, Reber[1] and Southworth[2] have measured it on short radio wave-lengths, using highly directive aerial systems. Appleton[3] has pointed out that it should be impossible to detect this temperature radiation at the longer radio wave-lengths, owing to the rapid falling off of solar emissivity, combined with the impracticability of using highly directive aerials on these wave-lengths. He and others[4] suggest that the radiations which *are* observed on the longer wave-lengths, and which appear to be correlated with sunspots, cannot be thermal in origin, since such an explanation would require solar temperatures of the order one million degrees and upwards. There is little doubt that these views, so far as they refer to temperatures *upwards* of 10^6 degrees, must be correct, especially in the light of recent evidence[5,6] showing that at such times the radiation comes from restricted areas in the immediate vicinity of sunspots. It is the purpose of this note to point out, however, that at such wave-lengths we should expect thermal radiation corresponding to values of T *downwards* from 10^6 degrees to the familiar surface temperature of order 10^4 degrees.

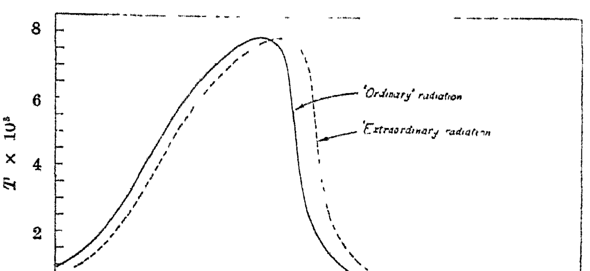

Fig. 1. EFFECTIVE TEMPERATURE OF SUN CONSIDERED AS A BLACK-BODY RADIATOR IN THE RADIO SPECTRUM

Studies by Baumbach[7] of the light scattering by electrons in the solar corona give reliable estimates of the electron densities in this region. Since the corona must be completely ionized, the electron collision frequencies may be calculated by the method of Chapman and Cowling[8]. It is then easy, by application of Milne's concept of optical depth, to show that solar radiations the wave-length of which is longer than about 1 metre must emanate from the corona. Now, Edlén's recent work[9], together with other spectroscopic evidence, shows that the coronal matter is normally at a temperature approaching 10^6 degrees. We should therefore expect to find black-body radiation of about 1 metre wave-length having a normal (quiet sun) intensity corresponding nearly to $T = 10^6$.

We may proceed to investigate the effective values of T at other wave-lengths by using Milne's criterion that the observed radiation comes from an average optical depth $\tau = 1$, where $\tau = -\int \kappa_\lambda dr$, κ_λ being the absorption coefficient and r the distance from the sun's centre. When we apply this criterion for wave-lengths shorter than 1 metre it is found that, as λ decreases, the radiation begins to emanate from the chromosphere, which is at a much lower temperature than 10^6 degrees, so that the solar emissivity falls off rapidly in this region of the spectrum.

On the long-wave side of 1 metre the corona becomes a reflector and τ is less than unity. This happens because of the exponential decrease of electron density and collision frequency in the corona as r increases. Assuming local thermodynamic equilibrium, we may apply Kirchhoff's law, so that the effective temperature now becomes $\kappa_\lambda T$. As λ increases, κ_λ decreases and the effective temperature falls off. There is thus a maximum in effective T in the vicinity of $\lambda = 1$ m. The results of detailed calculations of this kind are shown in Fig. 1 (full line). It will be noticed that the curve descends steeply on the short wave-length side of the maximum, and comparatively gradually on the long wave-length side. In the latter region the effective size of the solar disk will be considerably increased, since it is the corona which is responsible for the observed radiation. In practice, however, it will not usually be necessary to take account of this, because of pronounced 'limb-darkening', which we now consider.

So far, we have confined our attention to the effective values of T averaged over the whole disk. It is of considerable interest to examine the variation of T (the brightness) within the disk. Fig. 2 (curves *a–d*) shows this variation for a range of the longer wave-lengths. It will be noticed that there is a considerable falling off in brightness as the limb of the sun is approached. This effect is superficially similar to the 'limb-darkening' familiar to solar physicists in visible light. The causes, however, are fundamentally different. Limb-darkening in the visible spectrum is due to the fact that a rising temperature is encountered as we penetrate the photosphere. The light we see from the centre of the disk comes from lower and hotter regions than that which comes to us at the more nearly glancing angles on the limb. In the radio case the effect of temperature gradient *in the corona* is negligible compared with the falling off in κ_λ at the shallower angles of emergence as the limb is approached. For wave-lengths shorter than about 1 metre (Fig. 2, curves *d–g*) the solar atmosphere becomes optically thick over most of the limb, and a treatment more strictly analogous to that used by solar physicists may be applied. Since the temperature *decreases* rapidly as we pass from the corona to the chromosphere, it follows, however, that limb *brightening* should be observed in the radio case. This phenomenon should be very marked at wave-lengths of 60 cm. downwards. It should be capable of direct experimental test either by the use of highly directive aerials on centimetre wave-lengths, or at eclipses.

The discussion so far has neglected the effect of the sun's general magnetic field. Account can be taken of this factor by making a solar application of Appleton's magneto-ionic theory of the ionosphere. The total radiation now divides into two parts, the 'ordinary' and 'extraordinary', each with character-

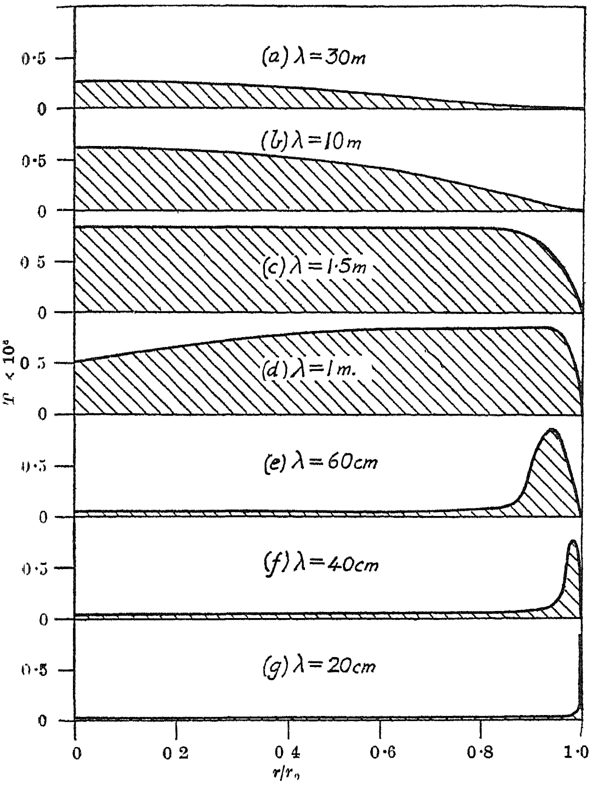

FIG 2 VARIATION OF RADIO 'BRIGHTNESS' ACROSS THE SOLAR DISK AT VARIOUS WAVE-LENGTHS ($r = r_0$ AT LIMB)

istic elliptical polarization of opposite senses of rotation. The discussion above may be taken with sufficient accuracy as applying to the 'ordinary' radiation. The distribution of 'extraordinary' radiation over the spectrum is shown by the dashed line in Fig. 1. It is seen that the intensities of these two characteristic radiations are markedly different over a wide range of wave-lengths. At first sight it might seem that this conclusion could be simply tested by the use of aerial systems alternately disposed to receive right- or left-handed radiations. Unfortunately, however, while the 'ordinary' radiation from the northern solar hemisphere is right-handed, the same radiation from the southern hemisphere is left-handed. For testing the above conclusion we must rely on statistical observations of the quiet sun over a period of time during which the solar axis is tilted markedly towards or away from the earth. Alternatively, observations could be made at eclipses or in regions providing a suitable horizon at sunrise or sunset.

As yet, few published observations exist which can be compared quantitatively with our conclusions. However, Southworth's original observations, which appeared to give $T = 6{,}000°$ in the region $\lambda = 10$ cm., have since been corrected by him[10] to give $T = 20{,}000°$, agreeing with the curve in Fig. 1.

The complete exploration of quiet sun solar radiation over the radio spectrum is probably beyond the resources of a single organisation, owing to the comparative inflexibility of the necessary equipment with respect to wave-length. It is hoped that the above conclusions, which appear to rest on well-established solar data and physical principles, may be of service to those planning regular observations in this field.

A full description of this work, which is part of the research programme of the Council for Scientific and Industrial Research, will be published elsewhere. I am indebted to Drs. R. Woolley and C. W. Allen for much advice on solar data.

[1] Reber, *Astrophys. J.*, **100**, 279 (1944).
[2] Southworth, *J. Franklin Inst.*, **239**, 285 (1944).
[3] Appleton, *Nature*, **156**, 534 (1945).
[4] Pawsey, Payne-Scott and McCready, *Nature*, **157**, 158 (1946)
[5] Pawsey, Payne-Scott and McCready, in the press.
[6] Martyn, *Nature*, **158**, 308 (1946).
[7] Baumbach, *Ast. Nach*, **263**, 121 (1937).
[8] Chapman and Cowling, "Mathematical Theory of Non-Uniform Gases" (Camb. Univ Press, 1939), 177.
[9] Edlen, *Ark f. mat Ast Fys*, **28 B**, No. 1 (1942).
[10] Southworth, *J. Franklin Inst*, **241** (March 1946)

OBSERVATION OF MILLION DEGREE THERMAL RADIATION FROM THE SUN AT A WAVE-LENGTH OF 1·5 METRES

By DR. J. L. PAWSEY
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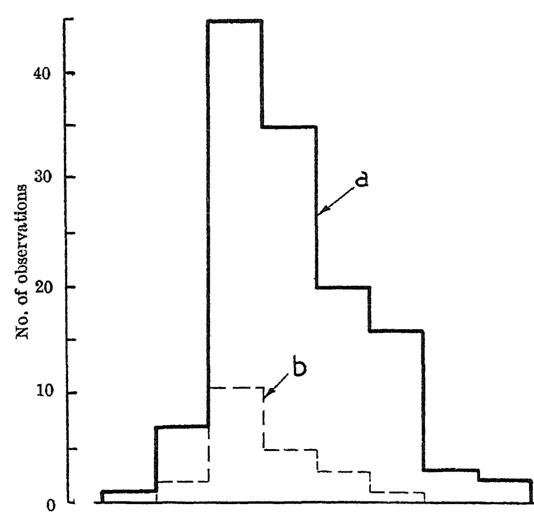
IN the preceding communication, Martyn has shown that at wave-lengths of a few metres, thermal radiation corresponding to a temperature of about a million degrees should be radiated from the sun. The detection of this radiation is complicated by the presence of a further source, which is highly variable and is associated in some way with sunspots. This source can, on occasion, yield radiation up to 100 times the expected thermal intensity. If we confine ourselves to intensity measurements, it would in fact be detectable only if the intensity due to the variable source, not infrequently fell below that of the thermal one.

Daily measurements of intensity on a wave-length of 1·5 metres over a period of about six months



HISTOGRAMS SHOWING DISTRIBUTION OF DAILY VALUES OF SOLAR RADIATION INTENSITY AT 1·5 METRES WAVE-LENGTH (INCREASES OF A FEW SECONDS ARE NEGLECTED). (a) DAILY: OCT. 5, 1945–DEC. 12, 1945; JAN. 1, 1946–MARCH 15, 1946 (R.A.A.F. OBSERVERS). (b) SUNDRY DAYS, MARCH TO MAY 1946 (LABORATORY OBSERVERS) indicate that this condition is satisfied in this part of the spectrum. The distribution of observed intensities is shown in the accompanying histograms. This distribution is markedly skew, having a sharp cut-off on the low side at the intensity range 0·5–1·0 × 10^{-15} watt m.$^{-2}$ (Mc./s.)$^{-1}$, corresponding to effective temperatures between 0·6 and 1·2 × 10^{6} degrees Kelvin. This distribution is consistent with the co-existence of a steady source, of intensity equal to the cut-off value, and a symmetrically distributed highly variable source, which, on this wave-length, exceeds the steady value for about 60 per cent of the observations.

The agreement between the observed cut-off intensity, which corresponds to a temperature of about one million degrees Kelvin, and the effective temperature derived by Martyn, 0·8 × 10^{6} degrees Kelvin, leaves little doubt that million degree thermal radiation is being observed at this wave-length.

I am indebted to Dr. D. F. Martyn for pointing out to me the probable existence of high-level thermal radiation, and to members of the Royal Australian Air Force and of the Radiophysics Laboratory who took the observations.

This work is part of the research programme of the Radiophysics Laboratory, Commonwealth Council for Scientific and Industrial Research.

RHEOLOGICAL PROPERTIES OF HIGH-VISCOSITY SOLUTIONS OF LONG MOLECULES

By Prof. F. H. GARNER

AND

Dr. ALFRED H. NISSAN

Department of Chemical Engineering, University of Birmingham

IN the kinetic theory of the elasticity of rubber, it is assumed that on straining at constant volume, the macromolecules depart from their most probable form with a consequential decrease in their entropy. This applies equally to the coiled or zigzag macromolecules in high-viscosity solutions in which, however, the groups of molecules have a much greater freedom of movement relative to one another than in an elastic solid. The assumption that such movement does take place on straining such solutions, in that groups of molecules increase their entropy by moving towards regions of less strain, can be used to explain a number of phenomena experimentally observed in a study of the flow properties of high viscosity solutions.

(1) When a jet of such a solution issues from a nozzle, new surfaces are formed and the molecules will be severely, though temporarily, strained; the entropy of the molecules at the surface will be less than that in the body of the jet. The spontaneous tendency for the molecules to move inwards will be exhibited by an apparent attraction inwards. Thus the dynamic surface tension of such solutions should show higher values than the static surface tension. Jets in the form of a hollow, conical, expanding sheet were ejected from specially shaped nozzles. The surface energy of the jets tended to contract them into cylindrical form, whereas the kinetic energy forced them to expand. The kinetic energy of the jet was adjusted until just sufficient to prevent the jet contracting, and was used to measure the dynamic surface energy. The apparatus, having been calibrated by Newtonian liquids, was then used on a solution of rubber in benzene which had a static surface tension of 29 dynes/sq. cm., and the dynamic surface tension appeared to be of the order of 150 dynes/sq. cm. Solutions of aluminium soaps in hydrocarbons similar in physical properties to that of rubber in benzene yielded apparent surface tensions ranging from 26 to 300 dynes/sq cm.; static surface tensions of these solutions were of the order of 22 to 25 dynes/sq. cm.

(2) At the entry into a pipe from a reservoir, it is postulated that the velocity would be uniform across the pipe. Immediately after entering the pipe, the boundary layer commences to thicken until it fills the whole pipe at the end of the 'inlet length'. Thus, there will be a strained layer next to the pipe with a core of relatively unstrained material. It is then expected on the above assumptions that there will be a spontaneous two-dimensional motion having radial and backward components. It is found experimentally that there is an abnormally high inlet pressure loss of the Couette type—that is, a pressure loss which is a function of the average rate of shear strain in the pipe; this can be equated to an extra length of pipe equal to a certain number of diameters, in contradistinction from the kinetic-energy type of inlet-pressure loss which cannot be so treated.

When the number of equivalent diameters was plotted against the rate of shear strain in the pipe, the inlet loss of head minus the kinetic-energy loss was found to be a unique function independent of the dimensions of the apparatus. The number of diameters increased with the rate of shear strain up to a maximum of 60 diameters, after which it decreased to an asymptote approaching zero diameters at very high rates of shear strain. In Newtonian liquids, the number of diameters is of the order of 0·6–1 due to Couette loss.

(3) In the main body of a pipe, the outer layers of a flowing solution of long molecules are at a higher rate of shear strain than in the centre. Relaxation by macroscopic radial flow inward cannot be achieved without straining other molecules by *outward* radial flow, therefore relaxation will take place in flow in a pipe on the molecular scale displacing the solvent molecules. This process implies a decrease in the concentration of the solute in the layer next to the pipe from the average. Diffusion of the solvent and interfacial phenomena will, however, restore the average concentration. This continuous interchange of energy between the solute and solvent molecules results in a certain amount of loss. As the rate of shear strain increases with the radius of the pipe, it follows that this extra loss of energy will be greater in the layers near the walls of the pipe than in those near the centre. In other words, the fluid will flow as if it were made of layers of increasing viscosities with increasing distance from the centre.

It will be appreciated that where the normal breakdown in viscosity with rate of shear strain exceeds this thickening, the overall effect of the two is a reduction in viscosity with increasing radial distance. However, where this relaxation process is strong enough, a phenomenon similar, but opposite in sign, to the 'sigma-phenomenon' exhibited by clay slips which flow with an apparent 'slip' should be expected. It is found that solutions of aluminium soaps in hydrocarbons on flowing in pipes, after correcting fully for end-effects, do reveal this apparent viscous layer, or surface-retarding effect, as predicted on these assumptions. This effect is complicated by other complex factors which cannot be discussed here.

(4) The solutions discussed in this communication belong to the pseudo-plastic group in which, as the stress is increased, the rate of strain increases to an even greater extent. The form of relaxation discussed implies an extra loss of energy on flow to that normally encountered, namely, the fluid should show a type of hardening which is a function of the space derivatives of the rate of strain rather than of the strain or stress themselves. Different types of flow in a pipe can result depending on the magnitude of this extra loss of energy.

(a) if it is small, the normal stress rate of strain curve is obtained;

(b) if larger, fluids appear to harden with increasing rates of strain,

(c) if it is very large, after an initial hardening, the rate of breakdown exceeds the hardening effect (which has a maximum value after which it decreases as described under 'inlet loss' above), then the total effect may be suddenly to initiate a regime of a rapidly decreasing resistance to flow with increase in the rate of flow. This would result in what can only be termed 'catastrophic flow'—a sudden rise in the rate of flow from low to extremely high values, when other regimes (turbulence) may set in to restore stability. Again, all these systems, including the interesting third type, have been realized in practice with systems of aluminium and calcium soaps in hydrocarbons which give rapidly relaxing, elastic, colloidal structures due to formations of macromolecules.

(5) Finally, this secondary flow can be observed visually as it takes place on a macroscopic scale in certain circumstances. A flat disk may be fixed parallel to the flat bottom of a glass beaker, and at, say, ½-cm. distance from it. The beaker is then filled with a solution of rubber in benzene (or soap in hydrocarbon) of fairly high viscosity. On rotation it will be observed that there is secondary radial flow from the periphery of the stationary disk inwards both above and below the disk. Small coloured particles will reveal the flow readily. Similarly, on rotating a rod partially immersed in such solutions, the liquid will be observed to climb up the rod from the line of strain to the regions of no strain where the adhering solution rotates with the rod.

It is hoped that an extended account of these experiments will be published elsewhere.

WAVE ENERGY: SIDEWAYS FLOW AND LOSSES BY THE SHORE

By P. J. H. UNNA

WHEN sea waves leave the open and enter a channel, they at once start to spend some of their energy along its shores, so that longshore strips of water, with low energy values, start near the actual points of entrance. This sets up energy gradients athwart the channel; and such gradients induce sideways flow of energy. The general effect is a drain of energy from mid-channel towards the shores; so that, well up channel, the strips of low energy will widen, and ultimately join, while the gradients will extend to correspond.

The results are that a sea running up channel should not be so heavy close inshore, and that the ratio of mileage to width of channel acts as a metaphorical though quite effective breakwater. Experience seems to confirm the first conclusion, provided that stream does not exert a disturbing influence; but the second of the two results is far more marked, and is the one which it is proposed to consider here

Let E be energy in ft.-lb./sq. ft., M be mileage, and W be width of channel. There is difficulty in estimating how much protection M/W can be expected to give, for there do not seem to be any data, theoretical or otherwise, for co-ordinating sideways flow with gradient. Assuming, however, that in given circumstances such as wave length or whatever may affect the issue, the ratio A, of wave power intercepted per mile of shore to wave power per mile width of channel, can be regarded as constant, E_M at M miles from the entrance should be given by $E_0(1 - 2A/W)^M$. That makes E subject to the law of compound discount, $2A/W$ being the rate. Strictly speaking, of course, A will not be constant, especially for small values of M/W, but it should become nearly so where the conditions are stabilized well up channel. In any event, the expression helps to show the sort of thing that happens, and to afford a basis for rough calculation.

To take the English Channel as an example, $W = 90$ for the first 140 miles measured from the Lizard–Ushant line, and it is then suddenly reduced to 55, and stays at that figure up to Beachy Head, where $M = 235$. Owing to the sudden contraction in width that is caused by the Cherbourg peninsula, all the energy that enters by the southern half of the fairway must inevitably be trapped in the Gulf of St. Malo. So only the northern half of the Channel need be considered, and off St. Albans, where $M = 140$, $E_{140} = E_0(1-A/45)^{140}$. This shows that $4\frac{1}{2}$ or 21 per cent of E_0 survives off St. Albans, according as to whether $A = 1{\cdot}0$ or $0{\cdot}5$. If $A = 0{\cdot}5$, the expression explains the heavy ocean swell of 20-sec. period occasionally noticed by Dr. Vaughan Cornish[1] as far up-channel as Christchurch Bay.

On the other hand, E at Beachy Head would be given by $E_{235} = E_{140}(1-2A/55)^{95}$, making E_{235} only $0{\cdot}1$ or $3\frac{3}{4}$ per cent of E_0, as the case may be. That shows that if Atlantic swell can ever be regarded as reaching Beachy Head, it must have died down to almost nothing.

It should be pointed out that the above considerations are independent of the character of the coast. With a rocky steep-to coast there is some possibility of a little of the energy being reflected; but it may be assumed that the waves are almost entirely broken up among the rocks. If, on the other hand, shoaling is gradual, there will be no reflexion at all of wind-formed waves. The third case is that of a bay breaking the continuity of the shore line; and any energy, once embayed, can be regarded as definitely trapped

In all three cases the energy gradient will cause the general alignment of the wave crests to be somewhat curved in plan, for the crests have to keep square to the direction in which the energy is flowing; but with gradual shoaling there will also be the much sharper curvature due to the waves slowing down as they shoal their water.

The general circumstances should be much the same if the shores converge gently, as in a bell-mouthed estuary, but dispersion will not be entirely dependent on shoreward flow of energy. All the energy would ultimately reach the shore, even if it were not diverted by a shoreward gradient, so losses by the shore arise from twofold action.

All the foregoing relates to ocean swell; but from what has been explained it should be clear that shore dispersion must also place definite and quite restrictive limits to the development of wind-forced waves within a narrow channel, say wherever W/M is less than 1. This shows the futility of investigating wave formation by taking measurements on a narrow lake.

Another common instance of sideways flow affecting E occurs when wave energy leaves the storm area of its origin. It must spread out sideways, whether or not there is a shore in the vicinity for it to reach.

Lastly, there is the case of seas rounding the head of a breakwater. Air photographs show that the wave crests just under the lee of a breakwater are circular in plan, and centre on its head; but here again, the law according to which the energy fans out does not seem to have been explained. Farther up the harbour, of course, the energy becomes uniformly spread across the channel.

It is unfortunate that these notes are so inconclusive, but they will serve their purpose if they lead someone to explain how sideways flow co-ordinates with gradient; for that seems to be a basic question in the theory of wind-formed waves.

[1] "Waves of the Sea", pp. 87–90.

APPLICATION OF 'GAMMEXANE' TO ARTHROPODS OF VETERINARY IMPORTANCE

By J. S. STEWARD

Imperial Chemical Industries Ltd., Biological Laboratories, Wilmslow

SINCE the announcement by Slade[1] of the discovery of 'Gammexane', several references have been made in the Press to its use in the control of pests of animals. As a considerable amount of work on this subject is being done in our own laboratories and by independent collaborators, it is felt that a brief résumé of the results so far achieved will be of interest. In this communication, 'Gammexane' refers to the gamma (γ) isomer of benzene hexachloride, and references to other authors' work are interpreted in terms of the gamma isomer so far as that is possible. The experimental preparation used was (except where otherwise stated) a dilution in water prepared from a 5 per cent solution of 'Gammexane' in a mixture of sulphonated castor oil and an organic solvent in proportions to give an easily pourable, miscible oil.

Diptera. The value of 'Gammexane' for the control of flies generally has been widely recognized. Against the sheep blowfly (*Lucilia* spp.), Harbour and Watt[2] found that good protection up to six weeks was obtained using a spray containing 0·5 per cent 'Gammexane'.

We have found that a spray deposit of approximately 40 mgm./sq. ft. produced lethal effects on the adult stable fly (*Stomoxys*), the residual activity lasting up to three weeks. With the sheep ked (*Melophagus ovinus*) this residual activity persists in long-woolled sheep for a similar period after treatment with dilutions of 1 in 25,000. The larvæ of *Hypoderma* in the back of infested cattle and *Gastrophilus in vitro* are relatively insusceptible. Excellent results have been reported on the treatment of wounds infested with the screw worm (*Cochliomyia hominivorax*), and the application of 'Gammexane' to open wounds was found harmless.

Against the orthorrhaphous Diptera, 'Gammexane' shows a high degree of activity, producing complete mortality of the aquatic larvæ of *Culicoides nubeculosus* after 24 hours contact with a concentration so low as 1 in 5,000,000; while *Simulium* larvæ succumbed to even greater dilutions (1 in 8,000,000) after an exposure of 1 hour followed by a change of water.

Anoplura. Both biting and sucking lice are highly susceptible to 'Gammexane' either as dusts or emulsions. Dilutions up to 1 in 15,000–30,000 in single applications give complete control of *Bovicola bovis*. With *H. eurysternus* somewhat higher concentrations were necessary, probably because these lice are found in places where the hair is short and sparse. The pig louse (*H. suis*) was destroyed by a single application of a castor oil – spirit lotion (equal parts by weight) containing 1 in 20,000 'Gammexane', which remained effective up to at least 27 days. *Trichodectes canis* and *Linognathus setosus* were eradicated from dogs bathed with 'Gammexane' emulsions as dilute as 1 in 40,000.

Siphonaptera. One application of 0·5 per cent 'Gammexane' dust has been generally found to rid dogs and cats of fleas and prevent re-infestation for some time. The breeding places of fleas require treatment as well as the infested animals. As a bath for infested animals, dilutions of up to 1 in 15,000 were effective.

Acarina. 'Gammexane' has proved effective against several genera of ticks (*Argas, Ornithodorus, Boophilus*). Hocking[3] eradicated *Ornithodorus moubata* from barrack huts by spraying the floor twice at intervals of three weeks (150 mgm./sq. ft.). Whitnall[4] has found that complete inhibition of egg laying of *Boophilus decoloratus* is obtained by 0·008 per cent, whereas for the same effect the concentrations of arsenic trioxide and D.D.T. require to be 0·32 per cent (as sodium arsenite in water) and 4 per cent respectively. The arsenic-resistant tick was found highly susceptible to 'Gammexane'. Taylor[5] found two applications of 0·1 per cent 'Gammexane' in liquid paraffin more effective in rat mange (*Notœdres muris*) than D.D.T. In these laboratories the same infection has been cured by dipping affected rats once for 30 sec. in dilutions so high as 0·01 per cent. Single-spray treatment of chorioptic mange of horses (legs) and cattle (neck and rump) has resulted in destruction of most of the acari and great clinical improvement for several weeks. Complete cure may have been obtained by single sprayings of 1 in 6–8,000 'Gammexane' dilutions.

Exact data on *Sarcoptes* spp. are not available, though promising results have been reported.

Dermanyssus gallinæ (red mite) has been considerably reduced by sprays of 1 in 5,000, and heavy infestations almost eliminated from hen houses sprayed with a 1 in 2,500 dilution. Elimination has been claimed by the use of 0·5 per cent dusts on perches and other harbourages combined with dusting of the birds.

Among the synthetic insecticides, 'Gammexane' is outstanding in acaricidal activity, and this important veterinary use is being investigated further. A fuller account of the results obtained is being prepared for publication.

[1] Slade, R., *Chemistry and Industry*, 314 (Oct. 13, 1945).
[2] Harbour, J. E., and Watt, J. A., *Vet. Rec.*, 57, 685 (1945).
[3] Hocking, K. S., *E. African Med. J.*, 23, 50 (1946).
[4] Whitnall, A. B. M., private communication (1945–46).
[5] Taylor, E. L., *Vet. Rec.*, 57, 210 (1945).

RECENT ADDITIONS TO THE LONDON ZOO

By Dr. EDWARD HINDLE, F.R.S.
Scientific Director, Zoological Society of London

THE replacement of the collections of animals in the care of the Zoological Society of London at Regent's Park and Whipsnade has progressed much more rapidly than could have been anticipated, and the recent arrival of the largest single consignment of animals ever to reach Great Britain will go far to complete the representation of the larger African mammals.

Contrary to general belief, very few animals at Regent's Park were killed as a direct result of enemy action, for although most of the buildings were damaged and some completely destroyed as a result of bombing, the inmates, as a rule, escaped any serious injury. However, during six years of war the number of animals has naturally become reduced, owing to normal mortality, accentuated by difficulties of feeding and shortage of staff. Very few replacements have been possible during these years, and by 1945 the collections were reduced in number, and not so widely representative as in normal times.

With the end of the War the replacement of gaps in the collection presented a very difficult problem, as, apart from the question of transport, it was no longer possible to obtain animals through dealers, many of whom had gone out of business, and all of whom were short of supplies.

The Society, as in the past, has been fortunate in receiving donations from Governments, public institutions, and private individuals, two of the most notable recent gifts being the giant panda, presented by the Szech-Wan Provincial Government, and two Kodiak bears and two Ceylon elephants, presented by Mr. Alfred Ezra, vice-president of the Society. Private gifts, however, are scarcely adequate to provide the requirements of such a large institution as the London Zoo.

The appointment, in 1945, of Mr. C. S. Webb as curator-collector of the Society has helped to solve this difficulty. Mr. Webb, an experienced and widely travelled collector, went out to East Africa towards the end of last year, and during the past few months has been successful in getting together a very large collection of mammals, birds, and a few reptiles, which have now reached Regent's Park.

The most valuable arrivals are probably the six young giraffes, belonging to three sub-species, including two Baringo, *Giraffa camelopardalis rothschildi*, three reticulated, *G. c. reticulata*, and an intermediate form, *G. c. cottoni*. The two latter have never been seen alive in Britain previously.

Other ungulates of interest include a lesser kudu, *Strepsiceros imberbis*, which has not been exhibited since 1886; a second Thomson's gazelle (the first arrived only last year), impala, duiker, water buck, bush buck, and two oribi. Last, but by no means least, a young black rhinoceros, *R. bicornis*, will provide an example of a family that has not been seen at Regent's Park since the War.

The primates include chimpanzees, Gelada baboons, guerezas, *Colobus abyssinicus*, and a very fine series of Brazza's monkey, *Cercopithecus brazzæ*. Of special interest are the melanic forms of a Galago (*G. crassicaudatus argentatus*), collected from a small area around Sotik, at the west end of the Mau escarpment of western Uganda. The typical silvery-grey form, which occurs in all the surrounding country, was never seen by Mr. Webb within this area, every specimen belonging to the black race.

The carnivores include three lions, four cheetahs, a leopard, and a lynx; six genets, two of which are melanic forms; and four species of mongoose, one of which, *Myonax sanguineus*, a black-tailed species, is new to the collection.

Edentates are represented by three aardvarks, *Orycteropus capensis*, a weird-looking animal of considerable interest in view of its many peculiar anatomical features.

The birds include ostriches, crested cranes, yellow-necked francolins, and two examples of the secretary bird, famous for its habit of destroying reptiles, a species which has long been absent from Regent's Park. Two beautiful species of crested guinea fowl, *Guttera pucherani*, from Mt. Kenya, and *G. edouardi seth-smithi*, from Lake Victoria, are already on view in the Pheasantry. There are four examples of the ground horn-bill, *Bucorvus cafer*, and the many smaller birds include at least four species new to the collection: two weaver-birds, *Pseudonigrita arnaudi* and *Ploceus rubiginosus*, a seed-eater, *Poliospiza striolata*, and several examples of crimson-rumped waxbills, *Estrilda rhodopyga*.

The reptiles include two African pythons, *P. sebæ*, and a hawk-billed turtle.

Some of the animals in this collection, including the giraffes, are already on view at Regent's Park, but others will have to undergo a period of quarantine before being exhibited.

ACHEULEAN CULTURE IN KENYA

ON the eve of his return to Kenya, Dr. L. S. B. Leakey recorded (*The Times*, October 4) a further remarkable discovery made by himself and his wife in the course of such archæological explorations as they were able to carry out during brief periods of leave from war duties. In April 1942, they found an outstanding site of the Acheulean culture of the early stone age at Olorgesailie, forty-two miles from Nairobi. While examining systematically a region of well-exposed ancient lake beds, they came upon an area thickly strewn with Acheulean hand-axes and cleavers. Further search revealed a number of distinct and different strata from which these specimens were being derived by sub-aerial erosion.

In 1943, further evidence was obtained pointing to the conclusion that on this site, now known as Olorgesailie site 10, there was a series of actual living-floors or camp sites of Acheulean man such as had never been found anywhere. The floors are inter-bedded between layers of lake sediment (clays and silts) on ancient land surfaces. It was evident that in the Middle Pleistocene period Acheulean man had lived on the shore of a lake of which the water-level was not constant, but had fluctuated over a long period of time. When the waters rose, the camp was flooded, and had to be abandoned; when the water receded the old camp had been sealed by layers of clay and a new camp was made. The same sequence of events recurred again and again, but on each occasion the returning stone industry represents a later phase of the culture A sequence of Acheulean culture "such as exists nowhere else" is thus made available for study. Fossilized remains of extinct mammals found here include many genera and species similar to those from Oldoway Gorge, Tanganyika—*Elephas antiquus*, the straight-tusked elephant, *Hippopotamus gorgops*, the hippopotamus with periscopic eyes, etc. All the bones which could contain marrow have been split to extract it, but there are no signs of fire.

Dr. Leakey's discovery would appear to open up a new vista in the study of the early stone age and will, with the discovery of the Rusinga jaw recently announced, prove of high importance in the annals of the study of primitive man. It may be pointed out, however, that a discovery very similar to that now recorded by Dr. Leakey, and also showing the cultural sequence, was made at Whitlingham, near Norwich, in 1926–27, when J. E. Sainty and H. Halls recovered from such parts of the site as they were able to excavate 543 specimens, ranging from Chellean to Mousterian, of which 173 were hand-axes or choppers, the majority Acheulean. Prof. P. G. H. Boswell, after examining the site, in reporting on the geological evidence, concluded that probably primitive man had camped and established his workshops here on gravel banks adjoining the old channel of the River Yare. Lest the reported statement that "the Acheulean or great hand-axe culture was first found in England by Sir John Frere in 1750" should be a trap for the unwary, it should be noted that it was in 1797 that John Frere, F.R.S. (1740–1807), the famous antiquary—he was neither knighted nor a baronet—discovered flints "evidently weapons of war" but now identified as Acheulean at Hoxne in Suffolk. The first recorded hand-axe found in Britain came from Gray's Inn Lane, London, in 1690 and is now in the British Museum.

Archæologists attending the forthcoming Pan-African Congress on Prehistory at Nairobi in January next (*Nature*, April 20, p. 548) will have the advantage of discussing the evidence of Dr. Leakey's war-time discoveries, including the Rusinga jaw, on the actual ground. No doubt argument there will clarify the issues in the recent tendency of opinion on the place of man's origin to swing back from Asia to Africa. It should certainly serve to integrate the problems of African prehistory, and in particular to place recent discoveries in both East and South Africa in true perspective.

RESEARCH AND THE SMALLER FIRM IN BRITAIN

A CONFERENCE arranged by the Manchester Joint Research Council on "Research and the Smaller Firm" at the Albert Hall, Manchester, on October 16, at which Dr. P. Dunsheath and Sir Edward Appleton presided over the morning and afternoon sessions, respectively, was remarkable for a disinclination, as revealed in the discussion following the papers, to rely on large research organisations either of the type of the Mellon Institute or the Battelle Institute, on the ground that it is better for individual officers of small concerns to make themselves responsible for research. Opposition to institutions such as the Mellon Institute with its system of industrial fellowships sponsored by individual firms was brought to a focus in Dr. F. C Toy's address at the afternoon session on "Existing and Potential Facilities for Research". In so far as the Mellon Institute is largely supported by the large firms, the soundness of the conception and the general confidence in the foundation can scarcely be questioned; nevertheless, Dr. Toy's paper indicated concern as to the future of the research association in Great Britain and its ability to win the confidence of the industry it served.

Mr. C. G. Renold's paper at the morning session, which was opened by Mr. A. H. S Hinchcliffe, dealt with internal organisation for the application of research, and discussed more particularly the management factor which is involved, as well as a scientific attitude of mind on the part of the leaders of industry and adequate facilities for the prosecution of research, to enable industry in Britain to be more responsive to the discoveries of science. The management problem involves three phases—recognition, investigation and application—and the responsibility for pursuing such work in all phases should rest on one individual, designated by Mr. Renold as the 'development officer'. That officer's duties as regards recognition and investigation present no great difficulty from the point of view of organisation, though even here it is open to doubt whether he can be really effective unless he has the status of a director. His duties in regard to application involve relations with the manufacturing side of the business and call for special techniques and practices of management. Mr. Renold had mainly the engineering industry in mind, but what he had to say about a foundation of authoritative specifications for raw materials, products and processes based on consultation with all concerned would apply to other industries as well. Mr. Renold would vest in the development officer the custody and upkeep of such specifications and the chairmanship of consultations in either formulation or revision.

Dr. C. J. T. Cronshaw's paper, "Technical Service—the Vital Link between the Producer and the Consumer", developed further some ideas implicit in his Mather Lecture to the Textile Institute last year, and he insisted that technical service has as its essential function the experimental investigation of the application of certain products within a consuming industry; its real value arises out of the unique knowledge acquired by research and experiment in its own laboratories. It is an abiding process of acquiring new knowledge, and it is not the function of technical service merely to provide a knowledge of the general science of chemistry, physics or engineering to a section of industry needing it. Dr. Cronshaw asserted that the function of technical service is to supply precise, specific and unique knowledge, and he then passed on to the quality of expertness. In doing so, he paid tribute to the skill and experience of the textile industry in Great Britain, and said that the only sure method of determining whether or not a new synthetic fibre would be a worthwhile addition to the range of fibres used by the textile industry is to put an appropriate quantity at the disposal of the industry and seek the initiative as well as the diversity of skill and talent of the firms within the industry. Sustained systematic search for novel products designed for some specific purpose involves inevitably a technical service department for the purpose of evaluating new products and serving as a link between the potential consumer and producer. While, however, a technical service can help and collaborate in the industrial use of new products, it cannot unaided solve completely the problems arising in different fields of industrial effort The small firm can utilize technical service just as readily as the larger firm.

Sir Edward Appleton, speaking at the afternoon session, said that the Department of Scientific and Industrial Research has given much thought to the problems of research and the smaller firm. He suggested that the industrial research associations should form the main reservoirs of knowledge on which the smaller firms should draw, stressing particularly the importance of efficient distribution of knowledge, supplemented by personal contacts, and the value of membership of more than one research association. He referred in general terms to the universities and technical colleges as the main source of new knowledge and fundamental research, and stressed the importance of having within the smallest firm those competent to assess the bearing of new knowledge on the products, processes or purposes of that industry. When facilities and staff are available, the Department of Scientific and Industrial Research will be prepared to assist a small firm by arranging to carry out special investigations into specific problems, although it is not possible to offer the same facilities as the Mellon Institute or the Battelle Institute—a statement which appears to conflict with Dr. Toy's remark that the research associations themselves are not encouraged to undertake work at cost for an individual firm.

SCIENCE IN RELATION TO THE COMMUNITY

THE Imperial College of Science and Technology has established an Inaugural Lecture to be delivered annually, and with no limitation of subject. The first of these lectures was delivered on October 25 by Prof. A. D. Ritchie, professor of logic and metaphysics in the University of Edinburgh. The following is an abstract of Prof. Ritchie's remarks:

To begin with, it is necessary to distinguish between science and technology. In popular use, the term science covers both. Though one man's activities may be such as to count as both science and technology, this does not happen often. Even so, the aims of the two are always distinct. The man of science is trying to understand. His practical activities are practice for the sake of understanding. The technologist is concerned with doing something useful. Though he must understand first, his understanding is for the sake of practice. However closely connected, the two have very different social responsibilities.

The final result of scientific investigation is a body of systematic thought. The scientific worker's responsibility is towards his fellow men of science, those who are capable of judging the value of his work; as to whether it contributes to their common system of thought. Nowadays, when science has become expensive, the man of science must count himself lucky, if those who pay for his piping let him call his own tune. If ever he is not allowed to, science will die out, and after that technology will petrify into routine and superstition.

The technologist is the servant of the public, directly or indirectly. His business is to plan or produce things which are useful and not harmful. His best efforts may sometimes be misused by other people through no fault of his own, but he has no right to assume that misuse is never his fault An architect planning a new housing estate, who designs a built-in cocktail bar for the houses but no accommodation suitable for children, has a great deal of responsibility for the social habits of the inhabitants. He may put forward two schemes, one with cocktail bar, the other with nursery and playroom, saying both cannot be had at the price, and leaving the choice to the politicians. But in the modern world, social problems are more and more tied up with technical matters, so that the technologist can and does force the hand of the politician far more than he used to.

The social conduct of those technologists we call medical men has been governed by a definite moral code—the Hippocratic Oath—as a result of which they have on the whole used their immense prestige for the good of the community. It has been suggested that all technologists should be bound by a kind of Hippocratic Oath. The man who has to draw up such an oath is not to be envied his task. It was easy for Hippocrates, as he dealt only with the relations between individual physician and individual patient, which are always much the same and for which a general rule can be laid down. Nowadays the technologist is concerned far more with large-scale collective relations. Each new problem is different from the last; general rules may do more harm than good. Still, there is one great danger ahead, which if seen may be avoided. The tendency now is for men to become the servants of their machines, instead of the machines the servants of men. The engineer's formula of efficiency may be merely an excuse to further this tendency, unless he remembers that people come first and machines second.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 4

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p m —Mr. J. G. Stewart: "Protein Food Production".

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. A. E. Bingham: "Modern Methods of Testing".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the INSTITUTE OF FUEL, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Dr. C. C. Hall: "The Operation and Development of the Fischer-Tropsch and related Processes in Germany".

Tuesday, November 5

CHADWICK PUBLIC LECTURE (in the Livingstone Hall, London Missionary Society, 42 Broadway, Westminster, London, S W.1), at 2.30 p m —Mr Asa Briggs: "Public Opinion and Public Health in the Age of Chadwick".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 15 p.m.—Prof. James Gray, F.R.S.: "Locomotory Mechanisms in Vertebrate Animals, 2, Transition from Water to Land; Origin of the Limb with Five Digits, Its Development for Propulsion and Support".*

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p.m.—Mr. W. F. Carey: "The Effect of Using Hot Air in Grinding Systems".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 30 p.m —Saw Tha Din: "The Karen People".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Princes' Gate, London, S.W.7), at 7 p.m.—Symposium on "How Accurate is a Photograph?" (Contributions by Dr. J. L. Tearle, Mr. A. A Ray and others).

Wednesday, November 6

SOCIETY OF DAIRY TECHNOLOGY, MIDLAND SECTION (at the Imperial Hotel, Birmingham), at 2.15 p m —Mr. F. R Pattison: "The Relation of Metals to Milk".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. D C. Espley, Mr. E C. Cherry and Mr M. M. Levy "The Pulse Testing of Wide-Band Networks".

Thursday, November 7

INSTITUTE OF FUEL, EAST MIDLAND SECTION (at the Gas Demonstration Theatre, Nottingham), at 3 p m.—Dr. A. L Roberts · "Radiant Heating—its Principles and some Applications".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 4.30 p.m —Prof. J. B S Haldane, F.R S.: "The Formal Genetics of Man" (Croonian Lecture).

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p m —Mr John Chear · "Birds and Man" (a colour film), Dr. V van Straelen. "The Belgian National Park, Congo Belge".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p m.—Prof. J. R. Partington. "History of Alchemy and Early Chemistry, 2".*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m.—Mr. A Allan and Mr D. F. Amer "The Extinction of Arcs in Air-Blast Circuit-Breakers"; Mr. H. E Cox and Mr. T. W Wilcox. "The Performance of High-Voltage Oil Circuit-Breakers"

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY, in Room 104, College of Art and Technology, Leicester), at 7 p m.—Prof J. B. Speakman: "The Promotion and Prevention of Milling Shrinkage".

TEXTILE INSTITUTE, LANCASHIRE SECTION (at the Chamber of Commerce, Richmond Terrace, Blackburn), at 7 15 p.m.—Mr. F. L. Barrett · "New Finishes".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m —Discussion on "Nitration" (arranged by Dr. G. M. Bennett).

TEXTILE INSTITUTE, BELFAST BRANCH (at the College of Technology, Belfast), at 7.30 p m.—Mr. D. T. Flodd · "The Uses of Starch in Textiles".

Friday, November 8

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. J. Chirnside: "Colour and Texture in Textile Design".

ASSOCIATION OF APPLIED BIOLOGISTS (in the Botanical Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 2 p.m.—Mr. S A. Barnett. "Rodent Control in Towns".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m —Dr. R. d'E. Atkinson: "A Proposed 'Mirror Transit Circle'"; Mr. H. W. Newton: "'Sudden Commencements' in the Greenwich Magnetic Records (1879–1944) and related Sunspot Data".

CHEMICAL SOCIETY, SHEFFIELD SECTION (joint meeting with the SHEFFIELD UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Dr. H. W. Thompson, F.R.S.: "Some Applications of Infra-Red Measurements".

INSTITUTE OF FUEL, SOUTH WALES SECTION (joint meeting with local branches of CHEMICAL SOCIETIES, at the Royal Institution, Swansea), at 5.30 p.m.—Mr. H. E. Crossley. "The Inorganic Constituents of Coal".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p m. —Discussion on "Current and Voltage Transformers for Protective Gear Purposes" (to be opened by Mr. J. G. Wellings and Mr. F. J. Lane).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. H. Hillier: "Feed Distribution and Hunting in Marine Water-Tube Boilers".

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p m — Discussion on "Testing Methods for (a) Pigments, (b) Media, (c) Paints".

ROYAL STATISTICAL SOCIETY, LONDON GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6.30 p.m.—Mr. K. A. Brownlee, Dr. B. P. Dudding and Mr. D. J. Desmond: "Some Applications of Multiple Correlation".

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (joint meeting with the MANCHESTER AND DISTRICT BRANCH OF THE INSTITUTE OF PHYSICS, in the New Physics Theatre, The University, Oxford Road, Manchester), at 7 p.m.—Dr. F. A. Vick · "Contact Potentials".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (joint meeting with the GUILD OF CALICO PRINTERS, BLEACHERS, DYERS AND FINISHERS FOREMEN, at St. Enoch Hotel, Glasgow), at 7 p.m.—"The Importance of Adequate Shrinkage in the Dyeing and Finishing of Fibro".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir D'Arcy W. Thompson, F.R.S.: "The Anatomist and the Engineer, a Study in the Mechanism of a Bird".

TEXTILE INSTITUTE, BOLTON BRANCH (at the Municipal Technical College, Bolton).—Mr. W. Barker: "Weaving of the Future".

Saturday, November 9

INSTITUTE OF PHYSICS, MIDLAND BRANCH (at the University, Edgbaston, Birmingham).—Dr. H. A. A. Boot: "The Cavity Magnetron".

Friday, November 8—Saturday, November 9

INSTITUTE OF PHYSICS, X-RAY ANALYSIS GROUP (in the Conference Hall of the Royal Victoria Hotel, Sheffield).*

Friday, November 8

At 2 30 p m.—Dr. A. J Bradley, F R S · "The Intensity Relations of Debye-Scherrer Powder Diffraction Lines"; Dr. W A. Wood. "The Application of X-Rays to the Study of Stresses in Metals".

Saturday, November 9

At 9 30 a.m.—Prof. G. I Finch, F R.S: "The Surface Structure of Metals"; Mr. H. J Goldschmidt: "An X-Ray Investigation of Electro-deposited Chromium"; Dr. A. H. Jay: "Some Successes and Failures in the Application of X-Rays to Industrial Problems"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned·

LECTURER AND INSTRUCTOR IN HORTICULTURE, a LECTURER AND INSTRUCTOR IN AGRICULTURE, and a SUPERINTENDENT for the Burlingham Horticultural Station—The Chief Education Officer, Norfolk Education Committee, County Education Offices, Stracey Road, Norwich, endorsed 'Agricultural Staff' (November 6)

SENIOR SCIENTIFIC OFFICER in the Directorate of Telecommunications Research and Development, London, of the Ministry of Supply—The Director of Scientific and Technical Administration (D), Ivybridge House, Adam Street, Strand, London, W.C.2 (November 7)

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS (temporary), and EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS (temporary), at the Guided Projectiles Establishment, Westcott, Berks.—The Director of Scientific and Technical Administration (D), Ivybridge House, Adam Street, Strand, London, W.C.2 (November 9).

LECTURER IN ELECTRICAL ENGINEERING—The Principal, Handsworth Technical College, Golds Hill Road, Handsworth, Birmingham (November 9).

LECTURERS (2) to teach (a) subjects in MECHANICAL AND AERONAUTICAL ENGINEERING, or (b) subjects in PRODUCTION ENGINEERING including PATTERN-MAKING, in the Mechanical Engineering Department of the Coventry Technical College—The Director of Education, Education Offices, Coventry (November 9).

LECTURER IN CHEMISTRY at the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough (November 9).

TUTOR for women students, with qualifications in CHEMISTRY, PHYSICS or MATHEMATICS, at the Bradford Technical College—The Director of Education, Town Hall, Bradford (November 9)

LECTURER IN MATHEMATICS—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (November 9)

ASSISTANT LECTURER IN PLANT PHYSIOLOGY—The Principal, Royal Holloway College, Englefield Green, Surrey (November 9).

ASSISTANT (male) at the Bodleian Library (Radcliffe Science Library), Oxford—The Librarian, Bodleian Library, Oxford (November 9).

MATHEMATICAL PHYSICIST as Head of the Theoretical Physics Section in the Laboratory at Battersea—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1 (November 11).

SENIOR ASSISTANT IN THE DEPARTMENT OF MECHANICAL AND MARINE ENGINEERING at the City of Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (November 11).

ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY at the Essex Institute of Agriculture, Writtle—The Chief Education Officer, County Offices, Chelmsford (November 13).

CHAIR OF AGRICULTURE at Wye College—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 13).

SENIOR LECTURER IN PHYSIOLOGY, and a LECTURER IN CHEMISTRY —The Registrar, The University, Sheffield (November 16).

MECHANICAL ENGINEERS (2) for service in the Sudan on the installation and maintenance of plant and machinery, including Diesel-engined pumps, cotton ginning factories and sawmills—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Agricultural Engineer'.

ENGINEER to assist in the planning and erection of an electrically driven cotton spinning and weaving mill and power station—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Cotton'

TECHNICAL DIRECTOR to co-ordinate and control the work of all technical departments, including a new Development Research Station —The Director, Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W 1, endorsed 'Technical Director'.

LECTURER (grade II) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, University College, Gower Street, London, W.C.1

RESEARCH ASSISTANT to work in the Information Section—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1

GRADUATE (young, with degree in Zoology) for research in Anthropometric studies—The Secretary, The University, Edmund Street, Birmingham 3.

METALLURGIST or PHYSICAL CHEMIST preferably with some experience in the metallography and general metallurgy of non-ferrous alloys, and a METALLURGIST with industrial or research experience in non-ferrous foundry work—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

DEMONSTRATOR IN PHYSIOLOGY—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

SENIOR LECTURERS IN PHYSICS AND MATHEMATICAL PHYSICS, LECTURERS IN PHILOSOPHY AND ZOOLOGY, and ASSISTANT LECTURERS IN HISTORY, PHYSICS, AND MATHEMATICS, at the University of Otago, Dunedin, New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

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RE-ORGANISATION OF DEFENCE IN BRITAIN

THE changes in the machinery of government announced in the White Paper on the Central Organisation for Defence have on the whole been well received. The plan outlined represents an adaptation of war-time practice. The Prime Minister remains chairman of the Defence Committee, and the Chiefs of Staff Committee will remain autonomous, with the responsibility for preparing appreciations of strategy and military plans and for submitting them direct to the Defence Committee, while the joint staff system will be retained and developed under the direction of the Chiefs of Staff Committee. While, however, the Service Ministers will continue to be responsible to Parliament for the administration of their Services in accordance with the general policy approved by the Cabinet and within the resources allotted to them, they will no longer themselves be in the Cabinet. They will be replaced there by a new Minister—the Minister of Defence—who will be deputy chairman of the Defence Committee and will carry the responsibility of co-ordination not only of resources between the three Services in accordance with the strategic policy laid down by the Defence Committee, but also the framing of general policy to govern research and development and the correlation of production programmes, as well as the administration of inter-Service organisations such as Combined Operations Headquarters and the Joint Intelligence Bureau, and the settlement of questions of general administration on which a common policy for the three Services is desirable.

While an eventual combined administration of the three Services is not excluded, the Government rightly regards this as an impracticable step at the moment, although it has in mind the possibility of closer links, for example, in the medical services, which at present are provided separately for each Service. While, as Lord Trenchard pointed out, complete fusion of such specialized Services might involve serious administrative difficulties and confusion, there are probably other directions, especially on the scientific side, where something more could be done towards the provision of common services, as, for example, in the field of radar. Moreover, assisted by the Joint War Production Staff, which is to be retained, the new Minister's Production Committee will be responsible for studying all, and especially the wider, aspects of our war potential, and there will thus be a considered attempt made to relate the size of peace-time stocks of equipment to the rate at which production can develop in emergency.

These proposals are largely in line with what Lord Hankey has advocated in his recent books, and with the proposals for constitutional reform outlined in the recommendations of a group of Conservatives in a book published under that title ("Some Proposals for Constitutional Reform, being the Recommendations of a Group of Conservatives." Eyre and Spottiswoode, Ltd. London, 1946. 7*s*. 6*d*.). Moreover, they are a step towards adopting the proposals of the Haldane Report, as Lord Samuel was quick to point out in the House of Lords debate on October 16. Lord Samuel said further that it was understood that other groups of Departments were in process of formation, and that just as Mr. Alexander was to bring the defence services together, ministries dealing with economic planning were being co-ordinated by Mr. Morrison, those dealing with social services by Mr. Greenwood, and those dealing with external affairs by Mr. Bevin. Lord Addison agreed with Lord Samuel that at long last some notice was being taken of the recommendations of the Haldane Committee, and this particular proposal of the White Paper calls for close study to see that it avoids the danger of creating a bottleneck above the three Service Ministries and the Ministry of Supply. Coordinating ministers without a portfolio, as both Sir John Anderson and Prof. K. C. Wheare have pointed out in recent lectures on the machinery of government, are likely to find themselves with little real authority; but it seems clear from the White Paper itself that the new Minister is in no danger of finding himself in that position.

Of special interest to the man of science are the observations in the White Paper on research and development, and on the great progress made in the direct association of scientific workers with the work of the Service and other departments. Recognizing that any future development of our central organisation for defence would be incomplete if it did not provide throughout for the closest possible integration of scientific and military men, the Government has now established a new Committee on Defence Research Policy which will be responsible, not only for securing such integration of thought at all levels, but also for seeing that, in planning defence research, account is taken of the scientific effort of the country in other fields in order that our resources may be efficiently and economically used. This Committee will consist of those responsible, both from the operational and scientific angle, for research and development in the Service Departments and the Ministry of Supply, and its chairman, according to the White Paper, will be a man of science of high standing, appointed for a period of years, who will exercise his functions under the authority of the Minister of Defence. The announcement on October 29 that Sir Henry Tizard had been appointed to this responsible post will give widespread satisfaction.

This development was warmly welcomed in the House of Lords debate, particularly by Lord Swinton, who stressed the value of putting the scientific man at the heart of operational planning and associating him with a problem from the start; by Lord Samuel, who pointed out that science is now a fifth factor no less important in the long run than the three Services themselves or the Supply Ministry, because the achievements and developments of science determine the whole course of military operations; and also by Lord Addison. Although Lord Hankey in his own speech did not mention this point, the appointment of such a Committee has long been urged by him, notably in his Lees Knowles Lecture last year, and the idea is implicit in his eleventh Haldane Memorial Lecture "The Machinery of Government" delivered in 1942 and also in the paper on the Cabinet Secretariat, put together twenty years earlier and published for the first time in "Diplomacy by Conference" (1946)

From this point of view, the proposal should also be considered in relation to the broader structure of research as set forth in the White Paper on Scientific Research and Development in 1944. The functions of the new Committee will in part overlap with those of the Scientific Advisory Committee of the War Cabinet set forth therein, and they will presumably include the functions of the Office of Scientific Advisers to the Ministry of Production abolished last year. Meanwhile, it is clear from Lord Addison's statement and that made by Mr. Attlee, and indeed from the White Paper itself, that the Government takes a wide view of the whole subject, and that there is no intention of isolating the new Committee on Defence Research Policy from the main current of scientific activity. The Defence Committee itself is recognized as concerned with plans affecting the whole life of the nation. If the White Paper does less than justice to the importance of home security and civil defence, it is clear that in excluding home security from the functions of the Minister of Defence, the Government has acted wisely. It will, however, be the duty of the Defence Committee to link home security problems to broad defence problems, and the Home Defence Committee has already been reconstituted for the purpose. Furthermore, the Prime Minister stated on October 30 that a complete review of the methods and organisation of civil defence is now in hand.

The success of such integration will doubtless depend largely on the extent to which the functional groupings of other ministries on the lines recommended by the Haldane Report are in fact proceeding, as Lord Addison appeared to admit. That change in constitutional practice may well be even more important than the changes in the organisation of defence; more particularly as the latter represent, as Lord Hankey agreed, a steady evolution and no drastic break with the past except in the change of title already noted and the question of co-operation with the Dominions on defence on which Lord Hankey, like most other speakers in the House of Lords, centred his criticism.

Lord Addison's reply suggested that no real disturbance of existing practice is intended in the question of collective defence, and it is obvious that both regional arrangements and national arrangements will require to be kept constantly under review while the Atomic Energy Commission is formulating proposals for the control of atomic energy and the United Nations Organisation is working out effective plans for collective defence. Even in the criticism of the section of the White Paper dealing with the organisation for collective defence, there was a very manifest desire to keep both British and Commonwealth arrangements in line with the plans and arrangements that might develop under the United Nations Organisation.

There are, however, two major matters on which there is some room for concern. Criticizing the statement in the historical commentary in the White Paper that failure to equip the British forces on an adequate scale was mainly due to the political and economic circumstances of the decade before 1939, Lord Chatfield said that he could see nothing in the White Paper to ensure that there would be no recurrence of similar political circumstances in ten or twenty years time, and he reiterated his plea that foreign policy should be taken out of political party strife. The absence of provision for consultation with the leaders of the Parliamentary Opposition was a major criticism of Lord Hankey, whose recent book includes a powerful argument for the association of leaders of the Opposition with the work of the Committee of Imperial Defence, particularly in linking foreign policy and defence. Lord Hankey believes that the endowment of the United Nations Organisation with military attributes enhances the importance of this point, and in its proposals for constitutional reform, the group of Conservatives already quoted points out that recent scientific developments have made it all the more essential to maintain the agreement between Government and Opposition to co-operate on vital matters of national defence. For that purpose a standing sub-committee of the Committee of Imperial Defence was proposed, which should include leaders of the Opposition, who should be Privy Councillors ; and it was suggested that the sub-committee should produce an annual report on the adequacy of the national and imperial defence organisation in the light of the existing international situation. This proposal is clearly intended to assist in the formation of that enlightened public opinion upon which the efficient functioning of a Parliamentary democracy depends. The flexibility of the new Defence Committee leaves the door open for such developments, and scientific workers should not need to be reminded of the importance of public opinion, as is shown by Lord Hankey in his Lees Knowles Lecture, or of his appeal to them and to other trained minds to attempt to appreciate the position and to assist others to do so also.

Ultimately, however, the effectiveness of the new machinery will depend, as was very clearly recognized in the debate, largely on the men who operate it. This is true at the top and also at the lower levels, where indeed Lord Hankey pleaded for tuning up details of administration to avoid risk of delays. Much will depend on our ability to find continuously the right man for Minister of Defence. We cannot expect that the Prime Minister will always be, as Mr. Churchill was so manifestly, the right man for the chairmanship of the Defence Committee and the mainspring of the war effort. But it will depend also on our ability to find for the chairmanship of the Defence Research Policy Committee and for other important posts the right men, not only of high professional qualifications, but also capable of rising above departmentalism and of co-operation in the fullest sense of the word. The central organisation for defence, in the ultimate resort, is a challenge to the quality of our man-power at all levels—administrative, scientific and technical—no less than to our capacity for statesmanship and political vision and courage.

CHEMISTRY THROUGH THE AGES

Die Entwicklungsgeschichte der Chemie

Eine Studie. Von H. E. Fierz-David. (Wissenschaft und Kultur, Band 2.) Pp. xv + 425 + 33 plates. (Basel: Verlag Birkhauser, 1945.) 21.50 Schw. francs.

If we include alchemy, chemistry must have a much greater literature than any other branch of science. Chemistry in the broad sense is, moreover, a science with a long history, extending over two thousand years. Any historian of chemistry who aims at describing its development within the limits of a single moderately sized volume must therefore make an arbitrary selection from the vast amount of data available. The most striking feature of the present book is the skill with which Prof. Fierz-David has made this selection, while to anyone with a sense of authorship the balance and construction of the narrative are things to be admired for themselves, quite apart from the substance of the book. The substance, however, matches the structure, and there can be little doubt that "Die Entwicklungsgeschichte der Chemie" will establish itself as one of the most authoritative and readable books in its field. It certainly ought to be translated into English.

Prof. Fierz-David remarks that, from the beginning, there were two quite different ways of regarding substances. One was the unsophisticated view which treated them as real objects forming a basis for an experimental art ; the other was alchemy, which looked upon experiment merely as the starting-point for philosophical speculation. It was from the practical art that, in due course, modern chemistry arose, and it might, therefore, seem logical to neglect the history of alchemy. In fact, however, alchemy and early practical chemistry were always so interlocked with one another that to follow such logic would entirely falsify the picture. The same sort of connexion existed between astrology and early astronomy, but astronomy shook itself free of astrology much more rapidly than chemistry ridded itself of the fetters of alchemy. In spite, therefore, of his eagerness to get to the history of chemistry itself, the author finds it necessary to devote about a quarter of the book to a review of the main events and tenets of the alchemical period. This section, while competent in matter and interestingly written, is not up to the standard of the remainder and shows a certain lack of judgment in its use of authorities. Thus, in dealing with Muslim chemistry, Prof. Fierz-David relies mainly on Berthelot—whose unreliability he himself admits earlier—and on von Lippmann, giving little or no mention to the work of Ruska, Stapleton, and others, which has so greatly enlarged and modified our knowledge of this important stage in the development of chemistry.

The account of the transitional period, from Muslim times to Boyle, includes brief but excellent summaries of the work of Agricola and Glauber, and the author is then free to turn to the fruitful century or so that began with Boyle and ended with Lavoisier. Unlike the majority of historians of chemistry, he maintains that the phlogiston theory of Becher and Stahl served chemistry well. It not only gave a reasonable explanation of the main phenomena of combustion as then known, but also allowed an unexpectedly happy correlation of apparently chaotically diverse facts. That phlogiston had no real existence is no more against the phlogiston theory than is the non-existence of the ether a blot on the escutcheon of nineteenth-century physics. They both rendered service in their days.

There will be no difference of opinion about Prof. Fierz-David's point of view that the real beginning of modern chemistry came with Lavoisier's establishment of quantitative analysis by weight. Before that time, when weighing was done at all it was usually of the original materials only—though we must claim an honourable exception in Black, whose name does not appear in the index or, apparently, in the text. By analysing and weighing the end-products as well, Lavoisier effected the crucial metamorphosis, and modern, exact chemistry was born—to grow with amazing rapidity under the stimulus of the new atomic theory of Dalton.

The remaining sections of the book show the author at his best. They are on unconventional lines but are refreshingly alive, being arranged, as it were, vertically instead of horizontally. The benzene theory, for example, is treated as an individual topic, as are such other subjects as stereochemistry, theories of solution, the periodic system, and radioactivity. In each case the story is brought up to the outbreak of the Second World War.

The final portion gives a very satisfactory bird's-eye view of modern applied chemistry, and there are various appendixes, indexes and charts. The book is well illustrated and produced, and its price must be considered very moderate. E. J. HOLMYARD

MICRO-ORGANISMS AND INSECTS

Insect Microbiology

An Account of the Microbes associated with Insects and Ticks with special reference to the Biologic Relationships Involved. By Asst. Prof. Edward A. Steinhaus. Pp. xi+763. (Ithaca, N.Y.: Comstock Publishing Co., Inc., 1946.) 7.75 dollars.

SCIENCE for its exercise requires a medium. In recent years, one after another of the natural sciences in search of such a medium has discovered the insects. Physiologists, chemists, even zoologists are finding among the insects a rich harvest waiting to be gathered. Microbiology, the latest of the biological sciences to demand recognition in its own right, has now entered the field.

In the golden age of bacteriology, as one disease after another fell before the advancing microbe hunters, medical and veterinary bacteriology developed as a craft of its own, the experts of which viewed the uncharted multitudes of non-pathogenic micro-organisms as being little more than a nuisance or at most as having only a negative sort of interest. Farmers, gardeners, brewers, cheese-makers and other industrialists have discovered the importance to them of microbiology, and new specialized areas of the subject have grown up. But it is only in quite recent years that it has been realized how lop-sided the growth of microbiology has become and how far our knowledge of pathogenic fungi, bacteria or protista has outstripped that of the harmless or free-living forms—to the detriment of the science as a whole.

The microbiologist who takes man or the mammalia as his point of reference will find a pretty varied field for his interests. There are the pathogenic viruses, rickettsiæ, bacteria, fungi, spirochætes and protozoa; the harmless denizens of the body surfaces and the intestinal tract; the organisms that play such an essential part in ruminant digestion; the phenomena of immunity. But compared with the microbiology of insects, what a narrow and restricted field it is!

Among the insects there are likewise pathogenic viruses, bacteria, fungi and protozoa. Some of these are responsible for the diseases that are so important in commercial insects: the polyhedral 'grasserie' and 'flacherie' of the silkworm which early attracted the attention of Pasteur, or the bacterial foul broods and the virus of sac brood in the honey bee. Others are important in the destruction of plagues of insects; when an outbreak of insects reaches its peak it commonly gives way before an outbreak of disease. *Coccobacillus acridiorum* will dissipate swarms of locusts; the European spruce sawfly, after threatening destruction in the forests of Eastern Canada, has melted away before a microbial infection; one of the most promising measures for the control of the Japanese beetle in the United States is the inoculation of the soil with the spores of *Bacillus popilliæ*, available commercially as a dry powder; and, on a homely scale, everyone is familiar with the spectacle of house-flies in the autumn dying off before the fungal infection *Empusa muscæ*.

But bacteria also form the staple diet of some insects. Certain ants and termites cultivate fungi in gardens for the nourishment of their colonies. The female 'ambrosia' beetles provide little fungal pellets to feed their young. Then there are the great number of micro-organisms pathogenic to plants and animals which have an insect as alternative host and carrier, undergoing within it such complex life-cycles as the plasmodium in the mosquito or the spirochæte in the tick. The problems of immunity, both cellular and humoral, to the microbes that invade it, likewise exist in the insect; and the subtle problem of the adaptation of the insect to carry pathogenic organisms. There are genetic races of *Culex pipiens* of which some can and others cannot serve as hosts for the plasmodium of bird malaria. There are strains of the leaf-hopper *Cicadulina* which carry a virus of maize, and other genetic strains of the same species which cannot act as carriers because the virus will not pass through the gut wall.

Scores of micro-organisms are harmless inhabitants of the body surface or gut contents of insects. But all degrees of mutual adaptation exist between host and microbe. The digestive enzymes in the cockroach are adapted to work in an acid medium created solely by bacterial fermentation. Fermentation chambers, stocked with cellulose-splitting bacteria, are characteristic of certain beetle larvæ from decaying vegetable matter. Protozoa and bacteria are essential for digestion in the wood-feeding termites; if defaunated they die of starvation. Bacteria may serve as a source of accessory food factors. An *Actinomyces* constantly present in the gut of the blood-sucking bug *Rhodnius* appears to provide some factor, perhaps a vitamin of the B group, that is lacking in blood. Intracellular micro-organisms (yeasts, bacteria and the like) transmitted from one generation to the next and maintained in special organs provide an endogenous source of vitamins for many insects.

Dr. Edward Steinhaus, who has been invited by the University of California to develop the study of the microbial diseases of insects, has produced the first introduction to insect microbiology. His book is described as a study of the biological relationships existing between microbes and insects (including ticks and mites), and covers the rich field outlined above—and much more. He does not include the fundamentals of bacteriology or protozoology but does give some account of the taxonomy of each group dealt with. Bacteria, rickettsiæ, viruses, protozoa, spirochætes, yeasts, fungi are all included Where knowledge exists it has been brought together here; the facts well marshalled and presented, and supported by copious references (about ninety pages of them). It is indeed a really solid book. In many parts of the subject, it is true, there are formidable accumulations of fact but few generalizations. As the author admits, some sections of the book are little more than annotated lists—sometimes perhaps of organisms the credentials of which are not beyond question. Two hundred and fifty identified species of bacteria have been found associated with insects and ticks. Some are wholly adventitious (such as *Clostridium tetani* in larvæ feeding in the soil), which scarcely earn the space they occupy in these pages. But it is a good book. The author has made it abundantly clear that the insect is a splendid medium for the study of microbiology. V. B. WIGGLESWORTH

A REFERENCE BOOK OF INDUSTRIAL RESEARCH

Industrial Research, 1946
Pp. 738. (London and New York: Todd Publishing Co., Ltd., 1946.) 21*s*. net.

A REFERENCE book on industrial research which provided in one volume not merely relevant information for which at present search has to be made in numerous volumes such as "Who's Who", "Whitaker's Almanac", the "Yearbook of Scientific and Learned Societies", the "Universities Yearbook", and the registers of various professional or technical associations, but also much that has not been brought together in this way, would prove a real boon to the busy executive, research manager or industrial scientific worker concerned with the planning or administration of research The present volume, however, misses the mark. Covering a wide field, it does so too imperfectly to replace, even for research purposes, such volumes as those mentioned, and it does little to supply the information which is lacking in those reference works and which they could not reasonably be expected to supply. The publishers show no clear conception of either the public for whom the book is intended or the precise purposes the book is designed to serve. Attempting too much, no field is covered thoroughly enough for reference purposes, and the resulting 'hotch-potch' is a bulky volume which cannot justify in its present form a place on the reference shelf of the library or the desk of the industrialist.

There are, however, at least two sections of the book which, suitably expanded, might make future editions a valuable reference work if some of the extraneous sections are eliminated. The directory of organisations interested in research, while rather generously interpreted and at present incomplete even on a narrower interpretation, could form the basis of a useful directory, particularly if some of the information scattered verbosely elsewhere in the volume were condensed into brief annotations in this list. Even more useful is the list of industrial research laboratories and the appended list of university laboratories, which contain information not easily available elsewhere. There is, moreover, in the former list much information concerning research staff which should have been included in the "Who's Who in Industrial Research". The latter section in its present form is singularly useless, and the publishers have missed their opportunity of gathering together the information at present scattered in "Whitaker's Almanac", the annual reports of the Department of Scientific and Industrial Research, the "Universities Yearbook" and various professional registers or directories. If the pamphlet "Notes on Current Scientific Researches in the United Kingdom" issued to delegates of the Royal Society Empire Scientific Conference, revised and brought up to date, were also incorporated in future editions of this book, possibly supplemented by a list of titles of theses on scientific subjects accepted by British universities for higher degrees during the year, the volume could become a valuable desk reference book for the research manager and industrial executive.

For the rest, there is little in the present volume that could usefully be retained in a reference work. The essays that comprise the first section are out of place. Some are reviews of current progress in special fields of the type one would naturally seek in, for example, the Reports on the Progress of Applied Chemistry. Nor are all these reviews new: one is a reprint of an article almost two years old. The relevance of others to the theme of industrial research is by no means evident, and their variety and discursiveness, whatever their individual merits, only emphasize the lack of thought and planning in the compilation of the book as a whole. The inclusion in this section of an article, "Common Hazardous Chemicals", reprinted from *Chemical and Engineering News*, illustrates the point: information on such matters would naturally be sought in Lange's "Handbook of Chemistry" or Hodgman's "Handbook of Chemistry and Physics".

The following section, "Official Directories", is also inadequate and much less informative than either "Whitaker" or the appendixes to the annual reports of the Department of Scientific and Industrial Research. Striking omissions in so omnivorous a volume are references to the Agricultural Research Council or the Medical Research Council—surely sufficiently closely linked with industrial research! The Overseas Section makes no reference to the South African Council for Scientific and Industrial Research or to the East African Industrial Research Board. The Official and Unofficial Statements which occupy the next two sections are unbalanced. There is remarkable disparity in the accounts of the various research associations, and in the absence of any attempt at classification the compilation is a little bizarre. The connexion of some of the organisations with research seems a little far-fetched, and others with much stronger claims to be included find no mention. For the most part it would be more effective to relegate the information in these sections to the Directory of Organisations as already indicated, and while it might be worth while including a fuller account of some, such as the Parliamentary and Scientific Committee or the University Grants Committee, the information should not be duplicated as at present.

The section "Officially Appointed Committees", listing a number of committees, some remotely connected with research, and with summaries of their reports, seems ill-conceived. It is not, and—unless carefully defined in scope—could not be, complete, but the purpose of summarizing the reports is not intelligible. References to the reports would much more appropriately have been relegated to the bibliographic section, and it would no doubt have been appreciated if that had included cross-headings facilitating the identification of the subject-matter and title of the many reports such as the Platt Report, the Hankey Report, the Barlow Report, which in common parlance go by the name of their chairman. Nor is the section on "Books, Periodicals and Films" adequate. In the nature of things, a book list in such a volume must be selective, but it could at least be authoritative and the basis of selection made plain. The present list displays all the worst faults of the whole volume, and the inclusion of so much triviality inevitably robs it of any pretensions to serve the one purpose that justifies the inclusion of such a list in a reference book on industrial research a guide to sources of reliable and authoritative information which those concerned with the conduct or direction of research whether at the policy-making or executive level might be expected to need.

R. BRIGHTMAN

A NEW FLORA OF GUATEMALA

Flora of Guatemala (Part IV)

By Paul C. Standley and Julian A. Steyermark. (Fieldiana: Botany, Vol. 24, Part 4) Pp. v+493. (Chicago: Chicago Natural History Museum, 1946.) 3.50 dollars

THIS is the first part to be published of a "Flora of Guatemala" which has been in preparation for the past six years at the Herbarium of the Chicago Natural History Museum. The Flora is based upon published records and earlier collections; in particular, it records new information obtained by the authors during four botanical expeditions of the Chicago Museum which extended to all the twenty-two departments of Guatemala. The authors state in their introduction that the flora of Guatemala, as considered in their work, includes that of British Honduras, which is continuous with that of the departments of Petén and Izabal: "There is no reason to suppose that in British Honduras there exists more than a handful of species that will not be found eventually in Guatemala". The work is thus of great importance for forest officers and students of the vegetation of the British Central American Colony. The only survey hitherto of the flora of British Honduras was Standley and Record's "Forests and Flora of British Honduras" (*Pub. Field Museum*, Bot. Series, 12; 1936) in which the systematic list was little more than a 'prodromus'; while there has been no previous flora of Guatemala.

The authors state in the introduction to this volume, which is Part IV of the Flora, that although almost all the manuscript has been written it has been found impractical to publish it in systematic order because of conditions imposed by the War. "Part I will include an account of the general features of Guatemala vegetation, a résumé of the history of its exploration, and other pertinent matter." Presumably, there will be a key to the plant families.

Part IV contains the accounts of a large number of families, including the important and difficult Moraceæ, Annonaceæ and Lauraceæ. The format follows the usual lines: there are keys (with macroscopic or field characters) to genera and species, ample generic and specific descriptions, relevant synonymy and citations of references, definitions of habitat and altitude, distribution by departments of Guatemala. The distribution of individual species outside the Republic is carefully defined, but only rarely are details given of distribution in British Honduras, except in instances where the species does not occur in Guatemala. Collectors' numbers, with the exception of those of recent type collections, are scarcely ever cited.

Of particular value and interest are the notes on properties, economic uses and vernacular names which follow the descriptions of many of the species. Many common Old World vegetables, fruits and garden favourites are wisely included.

The authors are enthusiasts and keen observers, who have acquired a very wide knowledge of the inhabitants and their customs in relation to the vegetation. The reduction of many species into synonymy and their frequent comments on variability show that they take a broad view of species. For the purposes of a flora of a tropical country this is probably more satisfactory than the provision of unworkable keys which maintain doubtful and critical species by selecting characters from descriptions or single collections.

The "Flora of Guatemala" promises to be the best of the numerous works of this kind with which Dr. Standley's name is associated. Clearly, then, the appearance of the all-important Part I should not be delayed.

N. Y. SANDWITH

SCIENCE AND ADULT EDUCATION

Progress in Science

By W. L. Sumner. Pp. viii+176+14 plates. (Oxford: Basil Blackwell.) 8*s*. 6*d* net.

IF it be true that the ability to think effectively on literary, economic, political and philosophical affairs does not take place until individuals have had experience of life, it is equally certain that there can be no real conception of the function of science in modern life before maturity. Belief in these ideas has, during the last decade, led to an awakened interest in the general education of adults and culminated in that section of the Education Act of 1944 which transformed a hitherto permissive right of local education authorities to provide facilities for adults to educate themselves in their off-duty hours into a mandate.

Among the extended facilities will be the provision of books and, as the Act becomes translated into practice, there will inevitably be a steady and rising demand for texts from the variety of study groups which spring up. If these classes develop as educationists envisage, it is hoped to draw in students from that section of the community which has previously been unattracted by any activity which could be put even under the broad heading of education. One of the obstacles which hinders the formation of such classes to-day is that there are few books suitable enough to be used as texts. The books provided for university extra-mural groups would be beyond most students and the books written for schoolchildren would alienate and be repugnant to them. In this field a rich harvest awaits the enterprising publisher who is sufficiently discriminating to obtain discerning and skilful authors who can fashion their pens to suit their readers. In the realm of science discrimination will be particularly necessary both because of its changeful nature and because the paucity of suitable contemporary books for the untutored offers little guide to would-be authors.

Which brings us to Mr. Sumner's book. During the First World War and since, almost unique opportunities were provided for expounding modern developments in science to large groups in the Armed and Civil Defence Services Surprisingly, although perhaps unavoidably, these opportunities were not taken by many men of science. Of the few Mr Sumner was one, and "Progress in Science" is an adaptation of the lectures and demonstrations which he gave to many Service audiences. Wisely he has confined his topics to technical developments during the last few years, and among those dealt with are electrons and their uses, the electron microscope, radar, television, the betatron, atomic energy, jet propulsion, the gas turbine, plastics, chemotherapeutic drugs and plant genetics. In the concluding chapter he discusses present-day researches the applications of which are still somewhat in the embryonic stage, and ranges over a wide selection of recent work.

Of his choice of subjects little more need be said than that it has been done well and with a discriminating awareness of the interests of adults although, since plant genetics is described in some detail, the omission of sections on human and animal genetics is puzzling. Of his manner of presentation it is enough to say that he has never forgotten that he has been writing for those only slightly informed of matters scientific. The importance of this interpretation of science to human society must take its place alongside fundamental researches in such subjects as nuclear physics. It is therefore to be hoped that "Progress in Science" will be the precursor to a long series.

T. H. HAWKINS

CURRENT RESEARCHES ON VITAMINS AND HORMONES

Vitamins and Hormones

Advances in Research and Applications, Vol 3. Edited by Prof. R. S. Harris and Prof. Kenneth V. Thimann. Pp. xv+420. (New York: Academic Press Inc., 1945.) 6.50 dollars.

THE third volume in the series vitamins and hormones amply maintains the standard set by its predecessors. As the editors say in their preface, "The subject matter of successive volumes will integrate more and more until 'Vitamins and Hormones' eventually becomes a complete reference to all active research in the vitamin and hormone field". The authors of the series of chapters are well chosen, and with few exceptions a high standard is maintained in each. Microbiological aspects of vitamins are discussed by Najjar and Barrett, in a chapter on the synthesis of B vitamins by intestinal bacteria, who summarize a subject of much topical interest; an article 120 pages in length (including 456 references) by B. C. J. Knight is an exhaustive review of growth factors in microbiology; amino-acids, purines, pyrimidines and naphthoquinones are discussed as well as the vitamin B complex. The threads of knowledge upon the interrelation of vitamins have been brought together by T. Moore in a suggestive article, and the influence of sulphonamides in experimental diets upon bacterial synthesis of vitamins discussed by Daft and Sebrell

J. Warkany deals with the important problem of manifestations of prenatal nutritional deficiency.

A suggestive article upon chemotherapeutic research and synthetic œstrogens is contributed by E. C. Dodds. The mechanism of action and metabolism of gonadotropic hormones in the organism is reviewed by Zondek and Sulman—in their words, "what happens in the interval between the administration of the hormone and the time when it takes effect in the organism?" Fifty-five pages are devoted by SubbaRow, Baird Hastings and Elkin to an exhaustive and authoritative account of the chemistry of anti-pernicious anæmia substances of liver which should be read by all interested in this subject; they show the stages in progress towards the isolation of the active factor; less than 1 mgm. from liver is now needed in place of 400 gm

Finally, in a somewhat more physiological article, Nachmansohn deals with the theory (his own) that acetylcholine is released at the neuronal surface during the passage of an impulse. By the action of acetylcholine the permeability of the membrane to ions is increased and hence a depolarization occurs. This theory is supported with much interesting evidence, though it is naturally also meeting with criticisms.

"Vitamins and Hormones" is a book which should be on the shelves of every library, and the private reader will find it a most useful book of reference.

R. A. PETERS

ELECTRICAL CONTACTS IN COMMERCE

Electrical Contacts

A Book of Reference for the Electrical Engineer. By Dr L. B. Hunt, with the collaboration of E. G. Pickering, Dr. J. C. Chaston, C. A. H. Jahn, E. H. Laister, H. R. Brooker, P. M. G Thorpe and N. A. Tucker. Pp. 122. (London Johnson, Matthey and Co., Ltd., 1946.) 10*s*. 6*d*.

THE author states that "The purpose of this book is to place at the disposal of the electrical engineer, in a form suitable for easy reference, information which will help him to make a wise selection of material and form of contact for the majority of applications". Undoubtedly physicists, metallurgists and other technical personnel concerned with contact problems will find the volume equally useful.

In the compass of 122 pages, much of which is taken up with excellent illustrations, it is only possible to treat the complex subject of electrical contacts superficially. Accordingly, Dr. Hunt and his collaborators have limited themselves to considerations of established English practice, and in particular with the products of the firms which they serve and under the ægis of which the book is published.

The problem of electrical contacts is dealt with under three main headings, namely, "Design and Selection of Contacts", "Properties of Contact Materials", and "Contact Engineering". Under the first of these, the influence of electrical and mechanical conditions on contact life and behaviour is discussed. The second describes in reasonable detail the properties of common contact materials, together with recommended applications. "Contact Engineering" deals with various methods of making different types of contacts.

The author has, perhaps wisely, refrained from discussions on the fundamental reasons for the service deterioration of contacts, and the numerous compositions listed serve to emphasize how little is really known of this subject.

There are a number of omissions, and, in particular, it is surprising to find no reference to lubricants for electrical contacts.

EDWIN RHODES

JOHN COUCH ADAMS AND THE DISCOVERY OF NEPTUNE*

By PROF. W. M. SMART
University of Glasgow

UNTIL 1781, the planet Saturn represented the outermost boundary of the solar system; on March 13 of that year the planet Uranus was discovered by Sir William Herschel, and by the beginning of 1846 (the year of the discovery of Neptune) five minor planets had been found. In all these instances, the discovery was made at the telescope, in one or two cases purely by accident. The discovery of Neptune was on a far different level of human achievement; the discrepancies between the predicted and observed positions of Uranus since its discovery furnished the means whereby two mathematicians, Adams and Le Verrier, applied their unrivalled skill to deduce independently the position of a new planet the gravitational attraction of which on Uranus, they confidently believed, was responsible for the discrepancies referred to.

When, shortly after 1781, an approximate orbit had been calculated for Uranus, it was suggested by Bode that perhaps the planet had been observed previously as a 'star'; the search of catalogues proved surprisingly successful, for no fewer than nineteen authentic observations of Uranus had been recorded, the earliest in 1690 by Flamsteed (the first Astronomer Royal), who designated it 34 Tauri. In the nomenclature of the time, these pre-discovery observations of Uranus are known as the 'ancient' observations, those after discovery as the 'modern' observations. In the second decade of last century the accurate establishment of the planet's orbit was undertaken by Bouvard, who was soon faced by a peculiar difficulty. If he used the 'ancient' observations alone, he obtained an orbit differing unmistakably from the orbit derived from the 'modern' observations alone, these covering nearly forty years. In this dilemma he rejected the 'ancient' observations entirely, on the plea that they carried very much greater observational errors than the 'modern' observations, and his tables of Uranus, published in 1821, were based entirely on the latter. But soon Uranus was seen to be falling behind its predicted position; by 1832 the error in longitude was $\frac{1}{2}'$, and in 1837 Airy (the Astronomer Royal) reported that the errors were "increasing with fearful rapidity"; the anomalous behaviour of the planet had now become the most puzzling problem in contemporary astronomy.

Several suggestions were offered to account for the phenomenon; the law of gravitation might not be exactly according to the inverse square of the distance (a suggestion regarded by Airy as possible even so late as 1844); the existence of a resisting medium—an ever-popular hypothesis—was put forward; perhaps the errors in the positions of Uranus were due to a massive satellite (how this could have escaped observation was not stated); perhaps about the time of discovery in 1781 Uranus had been hit by a comet, this suggestion being made, of course, to explain the difference in the orbits derived separately from the 'ancient' and 'modern' observations; and finally it was hazarded that the discrepancies—or, technically, the perturbations—resulted from the attraction of an undiscovered planet far beyond the bounds of Uranus. Airy himself had no doubts about the last hypothesis, for he wrote "If [the anomalous behaviour of Uranus] be the effect of any unseen body it will be very nearly impossible ever to find out its place". Fortunately, Adams and Le Verrier had a clearer perception of the problem than Airy, and they were little daunted by the difficulty and magnitude of the task to which in due course they applied their incomparable mathematical skill. From the beginning they were supremely confident of the existence of an unknown planet and of the power of analysis to ensure its optical discovery.

When Adams was still an undergraduate at St. John's College, Cambridge, he and a companion, Drew, were discussing their futures When Drew asked him what he proposed to do, Adams replied deliberately: "You see, Uranus is a long way out of his course. I mean to find out why. *I think I know.*" Drew said afterwards that this reply gave him a queer feeling, as if a young prophet were speaking Adams was born on June 5, 1819, the eldest of the seven children of a Cornish farmer. In 1836 his mother inherited a small property, and it seems almost certain that but for this 'windfall' the family economy —always exiguous—would never have stood the strain of a university education for the future astronomer. In January 1843, Adams was Senior Wrangler, and within a few months he had won the First Smith's Prize and had been elected to a College fellowship. Earlier, on July 3, 1841, Adams wrote his celebrated memorandum—now preserved in St John's College library—in which he expressed his determination to start operations, as soon as he had taken his degree, on the mathematical discovery of a trans-Uranian planet.

The problem to which Adams devoted his energies during 1843–46 was one of considerable complexity On the hypothesis of an unseen planet, the orbital elements of Uranus as deduced by Bouvard must be somewhat erroneous, for the observed positions of Uranus which he used must be affected by perturbations of which he was unaware; the corrections to Bouvard's orbital elements of Uranus constituted the first group of the unknowns in the mathematical formulation of the problem; to these must be added the mass of the hypothetical planet and the elements of its orbit. Owing to the way in which the mean distance of the new planet entered into the equations of condition it was necessary, if the problem were to be made practicable, to assume some value for this mean distance.

Adams, and afterwards Le Verrier, started with the value suggested by Bode's Rule as applied to the known planets. Before the end of 1843, Adams—he was then only twenty-four—had arrived at a preliminary solution which convinced him that the hypothesis of an unknown planet was adequate to explain the anomalous behaviour of Uranus. He then proceeded to introduce some necessary refinements into his mathematical investigations. By September 1845 he had made such progress that he was advised by Challis—then Plumian professor and director of the Cambridge Observatory—to place his results before Airy. Accordingly, when on his way to Cornwall for a holiday in September, Adams, armed with an introduction from Challis, called at the Royal Observatory, Greenwich, only to discover that Airy was in France. On his return from Cornwall, Adams again called on Airy (October 21, 1845); Airy was out at the time, but Adams left his card and a message to say that he would call in about an hour; he did so,

* Summary of addresses to the Royal Astronomical Society on October 8 on the occasion of the centenary celebrations of the discovery of Neptune.

but was informed that Airy was at dinner. Adams had perforce to depart, leaving, however, for the Astronomer Royal a "short statement" of the results of his researches, which, as we now know, were adequate to ensure the optical discovery of the planet at that time. Airy wrote to Adams fifteen days later putting his famous question as to whether Adams's theory could also explain the discrepancies between the values of the radius vector, as computed on Bouvard's theory, and the values which Airy had derived from observation. Adams did not bother to reply; he was not prepared to regard the question as other than trivial (although at the time he was only twenty-six, he was a master of planetary theory), and further he was disappointed that his efforts to make personal contact with Airy had proved fruitless. Adams's "short statement" remained in Airy's pocket for eight months, and probably would never have seen the light of day if events in France had not rescued it from oblivion.

In November 1845, Le Verrier read his first memoir on Uranus; this can be described simply as "Bouvard" amended and brought up to date; there was no mention of a hypothetical planet. In June 1846, Le Verrier read his second memoir, in which, after discussing the reasons for the necessity to assume the existence of an extraneous planet, he announced the position of a hypothetical body as deduced from his mathematical investigation; the mass and the elements of the orbit were not stated. The position obtained by Le Verrier was within a degree of the position found by Adams.

Towards the end of June 1846, Airy put the same query about the radius vector to Le Verrier as he had put to Adams eight months earlier. Le Verrier replied without delay, assuring the Astronomer Royal that his theory accounted automatically for the errors in the radius vector; further, he applied to Airy for assistance in the search for the planet, promising to send him at once fuller details of his work. This request for practical aid and the offer of more precise information passed unheeded; nor did Airy inform Le Verrier that mathematical investigations of a similar character had been in progress at Cambridge for nearly three years previously. A day before Le Verrier's letter reached Airy, the latter announced to the Board of Visitors of the Royal Observatory the almost identical results—as regards the longitude of the new planet—obtained by Adams and Le Verrier, and on July 9, realizing that the situation was indeed becoming "desperate"—as he described it—he wrote to Challis, the director of the Cambridge Observatory, asking him to undertake the search for the new planet with the Northumberland Telescope, at that time one of the biggest instruments in the world. Challis agreed, and the search began on July 29. In the absence of a stellar chart of that part of the sky in which the planet was believed to be situated, Challis had perforce to undertake a laborious programme of observations, determining the positions of all the stars within the suspected zone. Up to the end of September, when the news of the telescopic discovery of Neptune at Berlin reached Cambridge, Challis had made altogether 3,150 observations of stars and, as it transpired afterwards, had actually observed the planet on four occasions.

On August 31, 1846, Le Verrier's third paper was presented to the Academy at Paris; in this paper he gave the mass and the orbital elements of the planet and also stated that the planet should show a disk of about 3″ in diameter, which observations in due course confirmed almost exactly. Two days later Adams wrote to the Astronomer Royal giving him the results of a new solution of the problem, and, remembering Airy's former query about the radius vector, he indicated how reasonably well his theory fitted in numerically with the established errors of radius vector. There can be no doubt that, at this time, Adams was entirely ignorant that Le Verrier was hard on his heels; it is also certain that Le Verrier had no inkling of Adams's investigations.

On September 18, Le Verrier wrote to Galle, the assistant at the Berlin Observatory, requesting the latter to undertake the search for the planet; the letter was received on September 23, and Galle decided to start operations at once. A young student-observer, d'Arrest, suggested that the first thing to do would be to find out if Bremiker's star-chart (Hora XXI)—which included the zone in which the planet might be expected to be found—had been finished. A search in the director's house proved successful. There they found the edition of the relevant chart which had been engraved at the beginning of 1846 and which was being held back from distribution until another chart could keep it company in the post. Galle took charge of the telescope and described the configurations and magnitudes of the stars in the field of view, with d'Arrest checking Galle's observations on the chart. Soon Galle described the position of an eighth-magnitude star; d'Arrest immediately exclaimed: "That star is *not* on the chart". Subsequent observations confirmed its planetary character; the hypothetical planet had become a reality.

Naturally, there was great enthusiasm in France; Arago (director of Paris Observatory), referring to Le Verrier's achievement, declared that the discovery of the new planet "would remain one of the most magnificent discoveries of astronomical theory, one of the glories of the French Academy and one of the noblest titles of his country to the gratitude and admiration of posterity".

Into this atmosphere of rejoicing came immediately the first rude shock in the form of a letter from Sir John Herschel to the *Athenæum*, making the first public reference to Adams and to his investigations; Herschel's knowledge of these was limited to the information briefly given by Airy at the meeting of the Board of Visitors three months previously. A second shock was provided by Challis's announcement that he had been engaged at Cambridge in the search for the hypothetical planet since the end of July, and that since its optical discovery at Berlin a scrutiny of his observations had revealed the fact that he had actually observed it on four occasions. Except for a comparison of his observations on July 30 and August 12, Challis made no attempt to discuss the fruits of his toil, despite the sense of urgency which Airy's importunity and his own knowledge of Le Verrier's June paper would have seemed imperative to one who had even a modicum of faith in the results of mathematical analysis. Comparing his observations on August 12 with those on July 30, Challis noted that the first thirty-nine stars on the former date agreed with the observations on July 30; if he had gone on to star number forty-nine he would have seen that this star was absent from the records of July 30; this star was the planet. On September 29, before the news of the discovery at Berlin reached Cambridge, Challis, impressed with Le Verrier's insistence that the planet would show an unmistakable disk, noted against a star: "It seems to have a disc"; this again was the planet The fourth observation had been made on August 4.

As might have been expected, consternation reigned in Paris at what appeared to be an impudent claim to priority of discovery made on behalf of Adams. No wonder that Arago announced pontifically that Adams had "no right to figure in the history of the new planet, neither by a detailed citation, nor even by the slightest allusion". The defence of Le Verrier was promptly undertaken by Airy who, in a letter to the former, declared: "You are to be recognized beyond doubt as the real predictor of the planet's place". A little later he wrote. "No one will dispute the completeness of your investigations and the fairness of your *moral* convictions as to the accuracy and certainty of the results. With these things, the produce not only of a mathematical but also of a philosophical mind we have nothing which we can put in competition. My acknowledgment of this will never be wanting." It is to be remembered that Airy's knowledge of Le Verrier's work was confined to the three abstracts printed in *Comptes Rendus*, for the full mathematical investigation was published only towards the end of 1846. Later, Airy's opinion was less dogmatic. Writing to Biot in June 1847 he says: "I assure you that I have a very high opinion of Mr. Adams and that upon the whole I think his mathematical investigations superior to M. Le Verrier's. However, both are so admirable that it is difficult to say."

In the weeks following the discovery of Neptune, the French press was exceedingly bitter in its attacks on Airy, Challis and Herschel. English men of science were dumbfounded at the revelations of Airy's and Challis's shares in the transaction. Considering the latter first, we have his own word that he had very little faith in the outcome of theoretical investigations for detecting a new planet; he seemed to undertake the laborious series of observations merely because Airy was firm on the matter; and when he had embarked on the observational programme it never occurred to him to discuss his observations as they proceeded—except for the instance recorded earlier, and the comparison in this case was merely a test of the adequacy of the two separate observational methods he had adopted. Challis comes out of the Neptune episode as a sceptic and procrastinator, perhaps not earning, however, the almost brutal judgment passed on him by the historian of the Royal Astronomical Society.

It was Airy, however, on whom the greatest weight of criticism fell. His long silence as to Adams's investigations, his alleged 'snubbing' of Adams, but above all his fulsome praise of Le Verrier without any accompanying reference to Adams were the main points of accusation. Le Verrier, indeed, deserved every eulogy from whatever quarter it came; but the apparently pointed neglect of a young Cambridge graduate by the acknowledged head of British astronomy was something that no fair-minded person could understand. After reading the private papers of Adams and the contemporary literature, I am convinced that criticism of Airy was on some points unfair and unjustifiable; but I am equally convinced that his treatment of Adams in general was unbecoming to the leading astronomer of his generation. In any event some kind of action was called for. At the famous meeting of the Royal Astronomical Society on November 13, 1846, Airy read his "Account of some Circumstances Historically connected with the Discovery of the Planet exterior to Uranus"; he was followed by Challis, who described his observations at Cambridge, and finally by Adams, who outlined his theoretical investigations. In his "Account", Airy claimed to know the history of the whole business; but it is significant that of Adams he scarcely knew anything. In asking Adams for permission to insert in his "Account" such correspondence as had passed between them (this was Airy's second letter to Adams, the first being that containing the radius vector query) he addressed him as "The Rev. W. J. Adams"! Moreover, until then Airy, on his own confession, had met Adams only twice; on the first occasion he had forgotten where; on the second, in company with Hansen, on St. John's Bridge on July 2, 1846; each interview lasted no more than a couple of minutes. It seems extraordinary that on the second occasion—Le Verrier's second paper was by then known to both—two of the world's most eminent astronomers should meet the young Johnian without making some reference to his share in disentangling the most baffling problem in contemporary astronomy. Airy's "Account" contained several extraordinary passages, full of the liveliest eulogies of Le Verrier, but almost destitute of the deserved recognition of Adams's achievements. At the conclusion of his "Account", which in some measure must be reckoned a defence of his own conduct, Airy made one remarkable statement (its significance seems to have been overlooked by all previous commentators) to the effect that if Adams and Le Verrier had not adopted Bode's rule of distances they would never have arrived at the elements of the orbit. It is legitimate to ask if Airy really understood the problem of inverse perturbations so confidently and successfully tackled by Adams and Le Verrier, for unless some value of the semi-major axis, *a*, of the unknown planet is assumed, the problem becomes intractable owing to the complicated way *a* enters into the expression of the disturbing function. It was obvious to Adams and Le Verrier who, it must be remembered, were supremely confident of the existence of an exterior planet, that a 'trial and error method' was the only one to be adopted. They both soon found that the value of *a* must be considerably reduced—in other words that Neptune provided an exception to Bode's rule. If the rule had never been heard of, they must of necessity have adopted *some* value for *a* and proceeded on the lines of their respective investigations.

Challis had a most unenviable task at the meeting. A few days before, he had written to Airy: "I am in difficulties about this report [for the meeting] and should be glad to see some means of getting out of it". His 'report' was a confession of scepticism and procrastination. Adams's share in the proceedings took the form of a masterly account of his own investigations, concluding with a generous tribute to Le Verrier. It should be stated that he never took any part in the controversy that raged so long around his name, nor did he ever utter a harsh word about those to whom an inexperienced youth might have expected to look for guidance, advice and encouragement.

Perhaps the greatest slight to which Adams was subjected was the award of the Copley Medal of the Royal Society to Le Verrier on November 30, 1846. In this award the discovery was attributed to Le Verrier alone without any reference to Adams, despite the fact that those responsible for the award must have known about the proceedings at the Royal Astronomical Society meeting more than a fortnight before. The Royal Society was evidently of Arago's opinion that Adams had no right to figure in the history of the discovery of Neptune in any way. The Society, however, made amends by awarding to Adams the Copley Medal in 1848. The Royal Astronomical Society was saved by its by-laws from perpetrating a similar injustice. One medal and only one could be awarded; it was proposed, however, to waive the by-law *pro tem.* with the obvious intention of honouring both Le Verrier and Adams. This proposal in council was defeated. A resolution to award the Medal to Le Verrier alone was carried by 10 votes to 5, but as the by-laws stipulated a 3 to 1 majority the proposal was inoperative. Thus, there was no award by the leading astronomical society in the world for the most spectacular discovery in the history of astronomy.

Honours were immediately—and deservedly—showered on Le Verrier from all quarters. Recognition of Adams's achievements was much more tardy. It is worthy of mention that on the occasion of Queen Victoria's visit to Cambridge in the summer of 1847 the Vice-Chancellor was informed that "Her Majesty had commanded the honour of knighthood to be offered to Mr. Adams"; but Adams, against the advice of Prof. Adam Sedgewick, whom he consulted, modestly prayed to be allowed to decline the honour. About the same time he also declined the chair of natural philosophy at St. Andrews.

A subsidiary controversy—intimately connected, however, with the French claim on behalf of Le Verrier for the undivided credit of discovery—raged around the name to be given to the planet. It is usually stated that the name of Neptune (with a trident as the astronomical sign) was at first mutually agreed upon by Le Verrier and the Bureau of Longitudes. M. Danjon, director of the Paris Observatory, has recently informed me that there is no record in the Bureau confirming this; the name was certainly suggested by Le Verrier himself a few days after the discovery of the planet. But a little later, Le Verrier persuaded Arago to accept the discoverer's privilege of naming the new planet. Arago immediately announced that he had decided to name the new planet "Le Verrier", adding that in consequence there must be a wholesale renaming of the planets hitherto discovered (Uranus and five minor planets) in accordance with this new principle of attaching the discoverer's name to the planet discovered by him; for example, the name "Uranus" must now be changed to "Herschel". Both he and Le Verrier vowed that the new planet would never be referred to by them except by the name of "Le Verrier". At this time Le Verrier's complete mathematical investigations were presented to the Academy with the title "Researches on the Motion of the Planet *Herschel* (formerly *Uranus*)"; in the body of this large memoir the planet is referred to as Uranus, and Le Verrier explained in the preface that owing to the advanced state of printing it was impossible to effect the change throughout. This clumsy device of associating the new planet with Le Verrier alone met, quite naturally, with the unanimous disapproval of astronomers in other countries; it is perhaps worthy of mention that the Royal Astronomical Society Club—a festive body not usually prone to the discussion of serious subjects—was quite prepared to accept any mythological name proposed by Le Verrier. Soon the French astronomers were constrained to fall into line, and the name of Neptune passed eventually into established nomenclature.

The question as to whether Adams or Le Verrier should be accorded priority of discovery agitated scientific circles for several months. There could be no doubt as to the relevant events and their sequence. But could Adams's communications to Airy and Challis be regarded as 'publication', for no one disputed the fact that Le Verrier was the first to get into print? The fact that Adams was engaged in investigations of a trans-Uranian planet was known to various reputable astronomers in Britain and was the subject of general comment in Cambridge; it is true, of course, that Airy and Challis were alone familiar, at some time or other, with the main features of Adams's investigation and in possession of such information as to lead to the detection of Neptune in October 1845. The doctrine of priority was stated unequivocally by Biot in terms of "the common and imprescriptible law without which no scientific title could be assured that a discovery belongs to him who proclaims and publishes it to all". It is to Airy's credit that he explicitly denied the existence of such a law. Scientific workers in the past had adopted various expedients to ensure their titles to a discovery—the anagrams of Galileo and Huygens relating to the peculiar appearance of Saturn and to the rings of the planet are well-known instances. In later times the device of the 'sealed packet' became almost universal; Faraday, Wheatstone and Brewster adopted this expedient, which was even more popular with the Paris Academy of Sciences for, in 1846, no fewer than ninety were deposited and recorded in *Comptes Rendus*. There was thus some reason for the claim on behalf of Adams, for was not Airy the custodian of the young astronomer's results, and was he not responsible (in the last resort) for jogging the apathetic Challis to activity? The impartial verdict of the illustrious Struve may be quoted: "It cannot be denied that Mr. Adams has been the first theoretical discoverer of Neptune, though not so fortunate as to effect a direct result of his indications". In this centenary year there is no need for us to try to settle this vexed—and interesting—question of priority; rather do we hail Adams and Le Verrier as the co-equal sharers of one of the greatest triumphs of science.

But the element of dramatic surprise had not yet been exhausted. Using Challis's observations at Cambridge, Adams proceeded to calculate the elements of the new planet's orbit, as accurately as such observations permitted; the results proved to be in excellent agreement with results derived afterwards from more abundant observational material. It is interesting to note that Airy had little faith in such attempts. Writing to Adams near the beginning of 1847, he says: "I cannot conceive that you can obtain from the observations made at the now expiring appearance of the new planet any determination of its actual distance from the sun sufficiently accurate to be of the smallest service to you". In this opinion he showed a sad lack of appreciation of the possibilities of determining the orbital elements and, what was of the greatest importance, of using these for the search of 'ancient' observations, as was so successfully done in the case of Uranus. The surprising result of Adams's and other calculations was the comparatively small value of the semi-major axis of Neptune's orbit: this was thirty astronomical units as against about thirty-five used in Adams's and Le Verrier's solutions; no wonder that Peirce of Harvard was led to declare that Neptune was *not* the planet resulting from mathematical analysis and that its discovery must be accounted a happy accident. The arguments in refutation of such a suggestion are somewhat technical, and we must be satisfied on the present occasion with the mere statement that Neptune is indeed the fruit of Adams's and Le Verrier's genius.

Adams, now armed with satisfactory orbital elements, himself examined old catalogues in an attempt to discover 'ancient' observations of the planet, but his efforts were unsuccessful. However, Walker at Harvard and Petersen at Altona discovered an old observation of Neptune made by Lalande on May 10, 1795; this observation was marked 'doubtful', and it seemed bad luck that, out of so many thousand observations of stars, the only one that mattered in this connexion should be reckoned by Lalande to be unworthy of confidence. Subsequent reference to Lalande's manuscripts revealed the interesting fact that Lalande had observed the 'star' —as he believed it to be—on May 8, as well as on May 10; as the observations on the two nights were discordant he discarded the first and included only the second in his catalogue, labelling this as 'doubtful'. Instead of one unsatisfactory position of the planet, astronomers were now provided with two satisfactory positions, and these contributed very substantially to the accurate determination of the planet's orbit.

The subsequent careers of Le Verrier and Adams may be briefly indicated. For the former, a professorship of celestial mechanics was specially created in Paris; later he became director of the Paris Observatory. Le Verrier received the Gold Medal of the Royal Astronomical Society on two occasions in recognition of his masterly investigations in planetary theory.

Adams occupied the chair of mathematics at St. Andrews for a year, returning to Cambridge in 1859 as Lowndean professor; in 1861 he succeeded Challis as director of the Cambridge Observatory, where he resided until his death in 1892. He was president of the Royal Astronomical Society during 1851–53 (perhaps the most youthful occupant of the chair in the history of the Society) and again during 1874–76. In 1881 he was offered by Gladstone, then Prime Minister, the post of Astronomer Royal in succession to Airy, but this he declined. Adams's contributions to celestial mechanics were outstanding —perhaps no one has ever possessed such a thorough grasp of this most intricate subject, in which he was the acknowledged master.

LORD KEYNES: THE NEW THEORY OF MONEY

By J. R. N. STONE
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THE sudden death of John Maynard Keynes on the morning of Easter Sunday, 1946, deprived the world of the greatest economist of these times and Britain of one of her noblest sons. This article concentrates entirely on his principal contributions to economic science and leaves untouched the many other fields in each of which his achievements would seem to most men a fitting life-work.

Keynes' approach to economic problems was characterized by two separate features which are not frequently found together. On one hand, he was deeply interested in practical problems, and it was in their light that he viewed the propositions of pure economics. He can surely have had no equal in his broad grasp and understanding of contemporary economic events, and in this sense was an outstanding observer although he did not himself contribute largely to measurement and calculation. On the other hand, he saw practical problems through the eyes of a theorist well acquainted with contemporary and historical writings. He constantly compared his experience with existing theory and aimed at its correction and generalization where the comparison showed it to be deficient. He wrote of his endeavours in the preface to his greatest work, "The General Theory of Employment, Interest and Money" (1936), that they were "an attempt by an economist to bring to an issue the deep divergencies of opinion between fellow economists which have for the time being almost destroyed the practical influence of economic theory and will, until they are resolved, continue to do so". The attempt was successful; on the subjects of which he treated there is now, as is well known, a measure of agreement among economists which was unknown at the time he wrote, and which is directly attributable to his teaching. His ideas created an intellectual ferment wherever economics was seriously studied, and like all such basic contributions to a science are now well on the way to becoming the new orthodoxy. In his work at the Treasury in recent years, he and the younger men whom he influenced carried the new ideas on to the plane of affairs, and the changed official outlook, to which, for example, the White Paper on employment policy is a testimony, shows how conspicuous his success was in this field.

Keynes' most sustained contribution to economics lay in the field of what used to be called the theory of money but which has been transformed into a wider and more connected subject through his labours. He directed attention away from the purely monetary aspect of this subject towards an analysis of all the factors determining the level of aggregate demand for goods and services. In analysing effective demand he laid stress on the distinction between consumption expenditure and expenditure on additions to wealth or capital formation, or, in his terminology, investment. The concept of expenditure has to do with spending on goods and services; in addition, there is needed a concept of outlay which has to do with the disposal of income and may be divided into consumption outlay and saving. Now while the outlay and expenditure on consumption goods and services go hand-in-hand, a decision to save on the part of one individual does not automatically carry with it a desire to use that saving for investment purposes, since investment expenditure is in general undertaken by a set of individuals and businesses different from those undertaking the saving. From the definitions employed it follows that total saving is identically equal to total investment; but Keynes showed that under conditions where there is a tendency to excess saving, that is, where the amount which the community wishes to save at the full employment level of income exceeds the amount which is wanted for investment purposes in the same circumstances, an equilibrium level of saving and investment might be brought about by a reduction in income and therefore in saving, rather than by any factor in the situation tending automatically to raise investment demands to the level of full employment saving. He further argued that the former mode of adjustment would be the normal one in modern economic societies, and that an equilibrium situation could exist and might be expected at a level of income well below that which would accompany the full employment of resources.

The position can be seen in outline by a simple example. Suppose a constant rate of investment to be given independently of income. Saving (identically equal to income minus consumption outlay as above) is taken, in accordance with Keynes' 'psychological law', to be an increasing function of income. If we consider the graph of investment and of saving against income, we shall find a point at which the upward sloping saving–income line cuts the horizontal line representing the investment–income relationship. The point of intersection gives the realized level of income (identically equal to output in this simplified case), which in turn determines the level of employment. The equilibrium level of income is thus dependent on the behaviouristic responses of the community, which fix the point of intersection of the investment–income and saving–income relationships. This example is over-simplified and static, but illustrates the starting point of Keynesian analysis.

In Keynes' system saving is taken as a simple increasing function of income. Investment he regarded as dependent mainly on the anticipated yield of new assets on one hand and the rate of interest on the other. The rate of interest he analysed in terms of the supply of, and demand for, money. Thus money plays an important part in his system of equations and justifies the statement made above that this branch of economic analysis may be regarded as a development of the older theory of money.

These ideas can readily be developed in a symbolic form. It would not be appropriate here to attempt to set out a realistic model on Keynesian lines, but a simplified scheme which introduces dynamic elements may be helpful to those accustomed to the language of mathematics rather than economics. This example is representative of the kind of development of Keynesian analysis to be found in the works of the econometric school, but its relation to what has been said above will be obvious.

Let X_1 be consumption expenditure (identically equal to consumption outlay), X_2 be investment, X_3 be income and X_4 be saving, for a whole economic system, and let E be a unit delaying operator so that $E^n x_t = x_{t-n}$. The 'psychological law' in its dynamic form is represented by a 'propensity to consume' relationship which in its simplest form may be written

$$x_1 = aEx_3,$$

where the x_i are now the deviations from means of the X_i. Since $x_4 = x_3 - x_1$, the saving-income relationship is

$$x_4 = (1 - aE)x_3 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In this example we suppose that investment is unaffected by interest rates, and that expectations as to the yield of additions to the capital stock are based on total sales ($\equiv x_1 + x_2 = x_3$) in the previous period and the rate at which they were changing. On this hypothesis the investment–income relationship may be written

$$x_2 = (bE + cE^2)x_3 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Finally, the system is closed by the identity saving $\equiv$ investment, that is,

$$x_4 \equiv x_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If we write these three equations in homogeneous form and let $[\alpha E]$ be the matrix of operator polynomials, then $|\alpha E| x_i = 0$ is the generating function of the system. The movement over time of the system, if undisturbed by outside influences, is dependent on the coefficients of the powers of E in this expression, which in the present example can easily be seen to be, for successive powers, 1, $-(a+b)$ and $-c$. Thus, given the existence of the time lags, the question of whether the system is explosive, oscillatory or stable depends on the behaviouristic coefficients a, b and c

Starting from a simple case like this, allowance can be made for complicating factors by changing the number of variables and the number and form of the relationships, and by allowing for the fact that to some extent each equation is incomplete in the sense that only the principal determining variables can be included. In all cases the relationships either will be derived from the set of definitions adopted, or they will involve coefficients which summarize the average response of some part of the economy; and these may be either technological in the narrow sense or in a wider sense behaviouristic in that they sum up human responses. The problem in this field, as in others, is to see in the apparent confusion of actual experience the strategic variables and to relate them in the most succinct and fruitful way. The difficulty of doing this is especially great in economics, where the facts are complex and the available observations far from complete. Nevertheless, a scientific theory derives its principal interest from being able to represent experience; and the necessary knowledge to formulate such a theory in economics can be obtained only by combining, as Keynes did, the study of statistical material with a detailed knowledge of what takes place in actual economic life.

What, it may be asked, was new in all this? How did Keynes' theories differ from the many theories of the trade cycle that had already made their appearance? The gist of the answer to this question may perhaps be seen from the following considerations. First he aimed at what, mathematically speaking, was a complete explanation of the phenomena studied and did not concentrate, as many previous writers had done, on one particular phase of the trade cycle. Secondly, he linked together the real and the monetary aspects of the problem and found a place in his theories for confidence, expectations and similar psychological reactions, thus avoiding an explanation restricted to any one of these categories. Thirdly, he linked together the factors responsible for short-period changes with those operating to determine the average levels of the variables over longer periods, and showed that these average levels are also dependent on the quantitative responses of the system The importance of this finding is that there is nothing in the mechanism of change in economic systems as we know them to make the equilibrium level an optimum level; in other words, the norm of a system in terms of employment may be any fraction of capacity, and there is nothing tending to bring the system automatically to a full use of capacity. It was the necessity of accepting this conclusion that led to the reluctance of so many of Keynes' contemporaries to acclaim the new ideas when they first appeared. Finally, prescription followed diagnosis, and the practical means of avoiding under-employment, especially through the weapons of fiscal policy, stand out clearly as an integral part of his system of ideas.

Although he did not himself specialize in the careful measurements which form the basis of so much applied and statistical economics, he rated such work highly and encouraged it to the utmost He was always interested in the development of applied economics and played a leading part in the founding of the new research Department of Applied Economics at Cambridge.

It is of interest to note the part that the mathematical method played in Keynes' work. Since he read mathematics at Cambridge, it might be supposed that he would have employed it in his published work more than he actually did. He was, in fact, sceptical of mathematical economics, feeling perhaps, as Marshall did, that the mathematics involved was trivial, a view which nowadays can scarcely be sustained, and also that the complexities of the real economic world were not, at least in the present state of knowledge, to be ensnared in the mathematical net. His published comments on econometrics showed, however, that he paid it the compliment of serious, if not always comprehending, criticism. In private he was far more sympathetic, though a little impatient of the tentative character of this new treatment of economics.

Keynes did not regard economics as a subject of great cultural significance, but rather as a mundane matter which would have to be got right before human energies could be released from their present wearisome preoccupation with getting and spending. It is in achieving this goal largely by means of working out and applying his ideas that much of the energies of the present generation of economists will be absorbed.

BIOSYNTHESIS OF THE BELLADONNA ALKALOIDS

By Dr. W. O. JAMES
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THE origin of the tropane (and other) alkaloids in the plants that produce them has not been the object of much interest in the past. This seems to have been due to the sterility of the teleological approach to which they were subjected. They have been variously dismissed as reserve products of singular ineffectiveness, as flotsam thrown up on the beach of metabolism, and even as that final resort of the guesser hard up for a guess, a mechanism of detoxication. They are, nevertheless, very interesting substances for phytochemical investigation on account of their great variety, their relation to the proteins and the soluble nitrogen compounds, their specificity and the mystery of their coming and going. They are rendered especially suitable for investigation at the present time by the wealth of knowledge concerning their organic chemistry, and by the relative ease of their manipulation when compared with the other complex nitrogen compounds in the plant. The study of alkaloid metabolism may be expected to yield much information valuable to the wider study of the plant's nitrogen metabolism in general.

The necessities of war-time have acted as a stimulus in this field also; and a renewed attack upon its problems has become noticeable in Great Britain, in the U.S.S.R. and in the United States. In Britain, the Solanaceæ have been the favourite objects of study, particularly the *Atropa–Datura–Hyoscyamus* group, which is responsible for the tropane alkaloids[1]. The alkaloid content of young *Atropa belladonna* shoots collected from English sources in 1940 varied from 0·13 to 1·18 per cent of the dry weight. *A. belladonna* grows in discontinuous pockets over the chalk and limestone exposures from the south coast to the Scottish border, and tends to establish local races, which are botanically distinguishable from one another. They retain at least some of their distinctive features when transplanted to an agricultural site, or when raised from the seed of self-pollinations. A characteristic alkaloid content does not seem to be one of these permanent features; and there is so much variation between different parts of the plant and of the same part at different ages that any such constant would be difficult to establish.

The embryos and endosperms of the resting seeds of *Atropa* and *Datura* are without alkaloids. Alkaloids appear at an extremely early stage of germination, and are first formed in the meristem of the radicle. They can be detected by suitable methods when the radicles are 3 mm. long. The young epicotyledonary bud and the leaf rudiments as they form behave similarly and are soon possessed of demonstrable quantities. A series of analyses performed at weekly intervals throughout the life-history of the basal leaves of *A. belladonna* showed a high initial proportion (0·74 per cent dry weight), which fell steadily to 0·09 per cent when the leaves were yellowing. While the leaves were actively growing, the absolute amount of alkaloid per leaf increased to a maximum of 1·37 mgm. (as *l*-hyoscyamine). As soon as growth was complete the absolute amount of alkaloid in the leaf began to diminish and was only 0·32 mgm. at yellowing. Similar results were obtained with colchicine in autumn crocus leaves and appear to be general. They are compatible with the supposition that alkaloids are synthesized in the young and actively growing tissues and are broken down during senescence. Unfortunately, the position is complicated by translocation. It seems to be generally held at the present time that transport of alkaloids (nicotine and the tropane alkaloids particularly) through the phloem occurs scarcely or not at all. The entire absence of alkaloids from the sieve tubes has been repeatedly confirmed; and detached leaves have been shown to lose alkaloids at a fairly advanced stage of starvation. So soon as autolysis sets in, the loss is rapid and complete, and it is evident that the leaf possesses the necessary equipment for alkaloid degradation. The invasion of preformed alkaloids into the leaf by the agency of the transpiration stream is a highly probable event. It is the most obvious explanation of the fact, now well attested by numerous independent workers, that *Atropa* and related plants, grafted upon tomato stocks, contain no more than traces of alkaloids in their leaves. Conversely, tomato scions do contain alkaloids when grafted upon appropriate stocks. It is not a complete explanation, however, because detached belladonna leaves can be induced, as mentioned in more detail below, to increase their alkaloid content. At present, therefore, it remains possible that the leaf alkaloids normally have a dual origin: by synthesis *in situ* and by transport from the root.

The rapid appearance of abundant alkaloids in actively growing tissues occurs in other parts of the plant also. Primary root meristems contrast strongly with the older tissues behind them; and lateral meristems behave in a similar fashion. Young cortical and pith cells and secondary meristems such as phellogen also show a rapidly accumulating content. The general picture is of a synthesis running parallel with that of the proteins; the ontogenetic conditions that favour the one favouring also the other. The parallel is not quite complete, and detached belladonna leaves, incapable of protein formation, may still be able to synthesize their alkaloids. In this respect the obvious parallel is with the acid amides arising by secondary synthesis from the simpler soluble nitrogen compounds.

The quantity of alkaloid produced is to some extent under control through cultural methods, especially the appropriate use of fertilizers. Alkaloids are formed 'in competition' with other demands upon the nitrogen and carbohydrate stocks of the plant. There is an evident tendency to the establishment of limit values, and perhaps of variable, though not simple, equilibria between alkaloids and other nitrogen sinks, such as the proteins. The simplest and most reliable method of increasing the yield of alkaloid is to arrange for good vegetative growth of the plant. This implies a porous and calcareous soil, optimal spacing (about 30 in. × 30 in. for belladonna) and good general fertilization with perhaps an excess of nitrogen and lime. Under such conditions the yield of alkaloid increases *pari passu* with the general increase of plant material. To increase the percentage alkaloid, that is, to divert nitrogen and carbon from other metabolic paths into the alkaloid one is a more difficult and less certain undertaking. The only method at present holding out a prospect of success is unbalanced nitrogen manuring. Attempts in Great Britain both on the scale of pot cultures and field plots have shown significant but rather small increases of alkaloid per cent dry weight. A rather interesting feature is that additions of ammonium sulphate, so heavy as to stunt root growth, have caused increases in the percentage of alkaloids present. On other soils no increase has been recorded; the critical difference seeming to be deficiency of lime and absence of clay. The belief that liming in itself tends to raise the alkaloid percentage lacks experimental confirmation at present. A still more elusive, but highly interesting problem lies in the effect of the other major mineral nutrients, potassium and phosphorus. Results repeatedly show slight reduction of alkaloid percentage due to potassium, and slight increase due to phosphorus, particularly in the roots. The effect generally fails to reach a probability-level of 0 02 (19 to 1 odds) in any one experiment, but the summation difference between lack of potassium and lack of phosphorus may be highly significant. In view of the well-known effect of potassium in promoting protein synthesis, the apparent retardation of alkaloid formation affords an interesting suggestion of competition between the two processes for available nitrogen. The alkaloid is nevertheless a very unsuccessful competitor. In young belladonna leaves about 95 per cent of the total nitrogen is in the proteins and 0·3–0·9 per cent in the alkaloids.

It may be assumed that alkaloid synthesis begins with some fraction of the soluble nitrogen which constitutes 4–5 per cent of the total nitrogen. The amino-acids have long been regarded as the starting point of the synthesis and have commonly been assumed to arise by degradation of the proteins. The alkaloids are thus considered to result from protein breakdown followed by secondary synthesis. Such an origin for the belladonna alkaloids is indicated by experiments with detached leaves kept upon distilled water in the dark. No change occurs in the alkaloid content during the first two or three days; but at the stage where the leaves become noticeably yellow, and there is a rapid breakdown of proteins, the amount of alkaloid per leaf may increase. The increase is soon followed by a rapid loss of alkaloid as autolysis sets in. The increase is not very great, is evanescent and may be difficult to observe.

Whether the alkaloids are to be regarded as always derived from proteins depends on whether amino-acids can be formed first, or are the products of protein hydrolysis only. The fact mentioned above that alkaloids commonly arise in the *loci* of active growth, where protein breakdown is at a minimum, speaks rather for a primary origin. It has further been found that detached belladonna leaves fed with ammonium sulphate plus sucrose in the dark increase their amount of alkaloid per leaf more vigorously than leaves kept on water or sucrose solution only. Similar leaves showed no protein accumulation during such a period, and an intermediate formation of protein seems unlikely. In short, the alkaloid synthesis associated with protein degradation appears to be due to a somewhat greater persistence enabling it to take temporary advantage of the relatively high amino-acid concentration after the mechanism of protein synthesis has broken down. Amino-acids of either secondary or primary formation are potential alkaloid precursors.

It is improbable that all amino-acids are equally suitable for the role, and speculation in the past has favoured proline and ornithine as possible forerunners of the tropane alkaloids. Oxidation of ornithine by an α-amino oxidase yielding α-keto-δ-aminovalerianic acid is a not unlikely reaction, and the same product is obtained from proline by ring opening under the influence of a known variety of the enzyme. In this way the two amino-acids might be geared to a single synthesis.

Direct investigation by means of leaf-feeding experiments leads to the conclusion that $l(+)$arginine is the alkaloid precursor formed by belladonna. Young detached leaves fed with $l(+)$arginine have been shown repeatedly to increase their alkaloid content per leaf. The increases are small but statistically significant. Older leaves lose the capacity. In parallel experiments other amino-acids tested, glycine, *dl*-alanine, $l(+)$valine, $l(-)$leucine, $l(+)$glutamic acid, $l(-)$histidine, and $l(-)$proline have given negative results. On the other hand, $l(+)$ornithine gives rise to increased alkaloid contents, apparently in excess even of those obtained with arginine. The sharp distinction between $l(-)$proline and $l(+)$ornithine is striking and appears to rule out the joint oxidation hypothesis mentioned above.

In feeding experiments with arginine, especially if uptake is vigorous, leaves may develop signs characteristic of ammonia poisoning. The same mishap may occur during feeding with ammonium sulphate and can to some extent be mitigated by the presence of sucrose. It is not observed with the other amino-acids investigated, so is unlikely to depend on the α-amino group common to all of them. Its occurrence with arginine suggests the presence of arginase which hydrolyses arginine to ornithine and urea. The last might be further hydrolysed by urease to release the ammonia. Both enzymes have therefore been sought for and shown to exist in belladonna. The first may well be of significance in alkaloid formation, since it brings about the conversion of arginine to ornithine, which is not preformed in plant proteins or known from any other plant source. As well as in belladonna leaves, arginase has been found in the roots, in scions grafted on tomato stocks, in *Datura stramonium* and other solanaceous plants.

There are thus solid grounds for presuming that the nitrogen of the tropane alkaloids is derived from the δ-amino group provided by the arginine-ornithine group of amino-acids, and that the α-amino nitrogen of the other acids and the ring nitrogen of proline are not utilizable in the synthesis.

[1] Oxford Medicinal Plants Scheme, Annual Reports 1941-2-3-4-5.

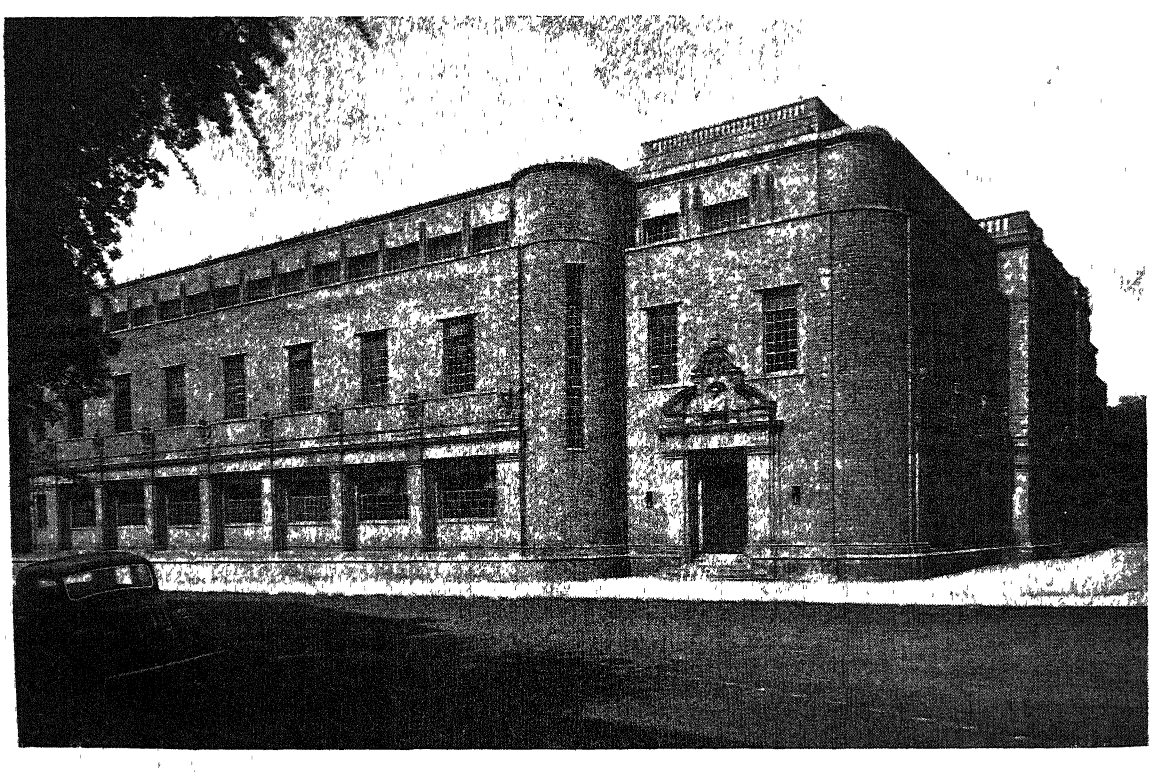
THE NEW BODLEIAN LIBRARY AT OXFORD

By Dr. A. S. RUSSELL

On October 24 the King, in presence of the Queen, Lord Halifax, Chancellor of the University of Oxford, Sir Giles Gilbert Scott, architect of the building, and a distinguished Oxford gathering, opened the new Library which has been erected at the corner of Broad Street and the Parks Road. The cost has been about £660,000, much of which was generously given to the University by the Rockefeller Trustees. Work on the building started in December 1936, and in the summer of 1937 the foundation-stone was laid by Queen Mary. The building was finished in 1940, and, but for the War, would have been formally opened in June of that year.

The New Library, as it is to be called, is a square stone block with frontages 41 ft. in height surrounding a central mass which rises 78 ft. above the street-level. The main problem for the architect and his helpers was how to get accommodation for five million books on a small site near the old Bodleian Library in the heart of the University area, where buildings of many periods are all low. Twelve years ago the University rejected the suggestion that the new building should stand by itself outside of the busy area. In consequence, a plan like that of the Cambridge Library, with book-stacks naturally lighted around open courts, and with a high central tower, was not feasible. The plan adopted was something like that of the new Library of Columbia University or of the annexe to the Library of Congress at Washington. In the centre is the main book-stack, starting many feet below ground-level and rising only to a height of 78 ft. It has eleven decks, each a little more than 7 ft. in height, of which three are below the ground and extend under the whole site. Six of the eight decks above the ground are entirely surrounded by the three floors of the outer range of rooms, and consequently, like the basement, are dependent on electric power for their lighting and ventilation. The topmost two decks of the stack rise above the rest of the building and so can be naturally lighted. The decks are fitted throughout with ranges of steel stack interrupted by gangways and having passages of about 2 ft. 6 in. wide between each range. There are many lifts and internal staircases to allow of communication between the decks. Throughout the stack there is plenum and extract ventilation, and the whole building is heated by water coming from a thermal storage plant in the basement.

Surrounding this great stack are the outer rooms, the frontages of which rise in three stories only. As room for many library needs are already adequately met in Bodley's Library, the Radcliffe Reading Room, the Radcliffe Science Library and the departmental University libraries elsewhere, the New



THE NEW BODLEIAN LIBRARY

Library rooms will be used mainly for special purposes. There are rooms for photography and for the reading of microfilms. There are a map room, a catalogue room, a bindery, a reading room able to accommodate eighty readers, and many rooms for research workers. The New Library, although its main purpose is to house millions of books, will help towards making them more accessible, especially for senior members of the University and those engaged in co-operative research.

Oxford differs from Cambridge in that books from its University library may not be taken out of it. Access to the stack, which will be granted to all serious readers wishing to have it, is thus of importance. A good deal of attention, also, has been paid to getting books from the stack quickly to readers in various parts of the old Library. A tunnel under the intervening street connects the basements of the old and the new Library, and a mechanical conveyor is at work there. This enables books to be taken to and fro from all floors on both buildings. A book starting from the stack, for example, descends to the basement, goes through the tunnel under the street and ascends to the old Library, where it is automatically discharged at the correct floor-level. There are ingenious devices so that messages can be sent quickly almost anywhere in the area, and the systems of ventilation and of air-conditioning ensure that the central heating will not damage, even over periods of years, the books that are housed there.

There can be no expansion on this site. It is not anticipated, however, that the new building will be full for another two hundred years at the present rate of intake of books. It is interesting to note how books can accumulate. In 1822, Bodley's Library had a modest total of 160,000 volumes. In 1888 this had risen to 440,000, and in 1915 to 1,000,000. Every year this growth—benign or otherwise as it may be viewed—has increasingly overflowed into neighbouring buildings and basements, and produced the attendant inconveniences of lack of access and delay. It has had one good effect. It has compelled the central library to be less hostile to the setting up of departmental libraries with open shelves. At one time the Radcliffe Science Library in the area of the Laboratories, with its open shelves, had to buy books, copies of which Bodley's Library received gratis and hid inaccessibly away. Since 1927, however, the science books in the old Library go straight to the Radcliffe Science Library, where the conditions for access are unsurpassed. Despite the setting up of such departmental libraries on various sites, the space available for books in the main Library would have completely vanished by 1940.

Not everybody likes the outside of the Library. It fits in with its neighbours moderately only, but its solid unpretentiousness grows on one with time. Dignified efficiency and an almost complete absence of ornament or architectural effects are what impress the visitor most in the interior. It is 'utility' raised almost to the point of genius. It is a civilized place for working in. It is the antithesis of some parts of the old Library, the characteristic of which was a funereal gloom, where no candle, lamp or even electric light was allowed for risk of fire. Sir Thomas Bodley, it is not generally known, was a lover and collector, in his day, of scientific instruments, and his ghost may well view the magnificent addition to the Library which he founded, where applied science has been summoned to bring books and readers comfortably together, not with consternation but with delight.

OBITUARY

Dr. Charles S. Myers, C.B.E., F.R.S.

When the complete history of the last forty years of development of experimental and applied psychology in Britain is written, it will become clear that an enormous amount of this development was due directly to the enthusiasm, foresight, scientific knowledge and organising skill of Dr. C. S. Myers. For some time there was no certainty that psychology would claim him for life. Literature, music, philosophy, archæology all attracted and held him, as well as natural science. It was, however, as a student of natural science that he gained an exhibition at Gonville and Caius College in 1891, and later a scholarship. He had a distinguished student career at Cambridge, where his interests turned chiefly in the direction of biological studies, and from physiology and anatomy he went on, through the influence of Rivers and Haddon, to experimental psychology and anthropology

Myers left Cambridge in 1895 and decided to take a medical qualification, looking forward, however, not to medical practice but to a life of research. As it turned out, he was offered, and accepted, a place in Haddon's expedition to the Torres Straits, and this was a crucial decision. He joined Rivers in an experimental study of the special senses and reaction-times of the natives of that area, and himself carried out his pioneer research into some of the characteristics of primitive music. Henceforward, psychology became the chief concern of his working life.

Back again in Cambridge in 1902, Myers began to assist Rivers in the teaching of experimental psychology in three rooms of a dilapidated building which were vacated by the pathologists. Students increased in number, and within a year psychology moved to a cottage which belonged to the University Press. Myers was still, justifiably, dissatisfied. He was working part of his time as professor of psychology at King's College, London, part of his time at Cambridge, and was engaged upon his famous "Text Book of Experimental Psychology". It was a busy life, but Myers still found time to agitate, organise, plan ceaselessly and in the face of frequent disappointments, for an adequate base in Cambridge for the subject that was nearest to his heart. In 1911, two years after he had given up his work in London, the first real steps were taken, and in 1912 the Cambridge Laboratory of Experimental Psychology, provided to an extent that few people ever fully realized by the splendid gifts of himself and his friends, became a permanent memorial to his energy and drive.

Before the new Laboratory could get into full swing, the First World War broke out. Myers surmounted all the difficulties that were put in his way and went overseas. He became eventually consultant psychologist to the British Armies in France. Here his very great organising and administrative skill for the first time got something like an adequate scope, though it was not until the Second World War that the work he then did came to full flower. More and more now his interests were turning to applied fields. He wanted to go on using psychology in the interests of medicine, industry, education and the Fighting Services. He was restless and even unhappy in academic life. In 1922 he severed his official connexion with Cambridge, and became the founder and director of the National Institute of Industrial Psychology.

Part of the story of the next twenty years Myers has himself told in his "Ten Years of Industrial Psychology"; but it is a small part even of the period covered. Only those who knew him very well indeed know what boundless energy, what ceaseless planning, what jealous regard went into the building and development of the Institute. It was an effort in the public service, actuated by very fine ideals and carried out with astonishing courage and great disregard for personal comfort. Some day, perhaps, its worth to the nation will be fully recognized. Certainly that day has not yet come.

Of Myers as a man and of his genuine scientific power it is not very easy to write. The most charming hospitality which he and his wife accorded his students in the early Cambridge days remains a cherished memory to all of us who knew it. He was not a very fluent speaker, and only those who were able to discuss quietly with him the problems, practical and theoretical, of his young science, knew how sure was his scientific grasp, how wide his knowledge, and how honest and unprejudiced his mind

Many honours came to him, which he carried lightly. He was the first to be elected a fellow of the Royal Society for specifically psychological work. He was awarded a C B.E., had honorary doctorates from the Universities of Manchester, Calcutta and Pennsylvania and held an honorary fellowship at Gonville and Caius College, Cambridge. He was widely known and esteemed in other countries, was president of the International Congress of Psychology in 1922, and twice president of the Psychology Section of the British Association. He was largely responsible for the founding and fortunes of the British Psychological Society, and one of the early and most successful editors of its journal.

What Myers could have achieved if he could have schooled himself to a single-minded pursuit either of scientific investigation on one hand or to a complete immersion in practical affairs on the other, it is possible only to guess. He certainly had rare qualities, deliberate to be sure, of width and accuracy of knowledge, of devotion to exact method, and of imagination which could have led to very outstanding personal achievement in psychology, or anthropology, or medicine. He had also the grasp, the energy, the capacity to inspire personal loyalty and a good deal, at least, of the impartiality which go to make the absolutely first-rate organiser. He never quite squared these two interests. The second robbed him of the leisure for the first, and the first always left him a little dissatisfied with the second. In fact, I believe, having sized up the probable consequences, he chose to devote his working life to the service of man, and from the path along which this decision led him he did not swerve.

F. C. BARTLETT

NEWS and VIEWS

Nobel Prize for Physiology and Medicine: Dr. H. J. Muller

IN any treatise on modern genetics, H. J. Muller figures as the man who discovered the action of X-rays on chromosomes and genes. It is this association which at once comes to the mind of the biologist on learning of the award to him of the Nobel Prize for Physiology and Medicine for 1946. Yet this spectacular and in a way crowning achievement of his scientific career, when seen in the perspective of his whole work, is only one step along a road which was planned with brilliant foresight and imagination, and followed with critical and untiring accuracy. In 1927, when Muller at the Genetical Congress in Berlin first produced definite proof that X-rays cause mutations, similar attempts, although without clear success, had already been made by a number of workers, and actually in the following year Stadler and others announced positive results of independent X-ray experiments with plants. Thus it was not the bare discovery of the metagenic action of X-rays which revolutionized genetics, but the manner in which Muller's previous work had paved the way for the use of it, and the genius with which he exploited it. First, in co-operation with T. H. Morgan in Columbia, later in the University of Texas, he had with great ingenuity used the fruitfly *Drosophila* to develop strains and methods, such as the *ClB* strain and balanced lethals, which formed and still form the basis for accurate tests of mutability. These methods, which already had borne fruit in studies of spontaneous mutability and its dependence on temperature, carried out by Muller alon[illegible] in co-operation with Altenburg, could now be h[illegible] the service of the new powerful agency for p[illegible]g mutations. With their aid, progress in the new field was amazingly rapid. During the twenty years since its beginning, radiation genetics has proved a means of approach to a great number of fundamental problems of genetics: types of mutation, chromosome mechanics, gene action, position effect, size of gene, nature of mutation, to name only a few of them; and a very large share of the subsequent work has been due to Muller himself, or has at least been inspired or guided by him.

Muller's outstanding share in mutation and radiation genetics is apt to make us overlook that he has left his impress on almost every branch of genetics. In his early days he took a prominent part in the development of the theory of crossing-over, and from the beginning, when he studied multiple and modifying factors, to his recent papers on "Reversibility in Evolution" and "The Role of Isolation and Temperature in Evolution" he has been a powerful advocate of the neo-Darwinian theory. Although his main work has been carried out with *Drosophila*, he has always been quick to realize possibilities inherent in other material. It is probably not widely known that it was Muller who in 1925 inaugurated the study of identical twins reared apart, which later on has been taken up so successfully by Newman and his school.

It may be asked wherein the benefit of his work to medicine is to be found. There appear to be two reasons for this. The first, more superficial one, is the help which radiation therapy has derived from a knowledge of the nuclear phenomena on which its results are based, and also of the dangers to the germ cells inherent in all work with high-energy radiation. The second points to the much larger benefits which medicine, especially preventive medicine, and eugenics are likely to derive in the future from an application of genetical knowledge and theory to problems of human health ; in so far as modern genetics is inextricably bound up with the work of H. J. Muller, his will be a very large share in this hoped-for gain to human welfare and happiness.

University College of the West Indies

THE Secretary of State for the Colonies has decided, after consideration of the report of the West Indies Committee of the Commission on Higher Education in the Colonies, to adopt the Committee's recommendation that a West Indian University College should be established in Jamaica. In the first instance the College will be given the status of a university college and will prepare its students for the degrees of the University of London. It is hoped that this formative period will not be prolonged beyond the minimum time necessary to establish the reputation of the College as a centre of teaching and research He has further decided, in agreement with the University of London, which sent two delegations to the West Indies to investigate the problem on the spot, that the temporary medical school which the Committee recommended in anticipation of a permanent Medical Faculty of the College, should also be established in Jamaica as an integral part of the College. The further measures required to establish the College and temporary medical school are already under discussion between the Colonial Office and the academic bodies and Colonial Governments concerned.

Dr. T. W. J. Taylor, C.B.E.

THE appointment of Dr. T. W. J. Taylor as principal-designate of the new University College of the West Indies deprives Oxford of a versatile chemist and a man of an almost unique range of experience Elected scholar of Brasenose College from the City of London School in 1913, his undergraduate career was interrupted by active service with the Essex Regiment (Gallipoli and France) during 1914–19. Returning to Oxford in the latter year, he got a 'first' in chemistry in June 1920 and was elected to a fellowship at Brasenose. For the ensuing twenty years he tutored the Brasenose chemists and served as a demonstrator in organic chemistry at the Dyson-Perrins Laboratory. Most of his published researches are concerned with stereochemistry, and his work on oximes is well known. With Dr. (now Prof.) Wilson Baker he undertook with notable success the task of revising Sidgwick's "Organic Chemistry of Nitrogen" · he also edited the second volume of the English revision of "Richter". He found time to visit the United States and Canada as Rhodes Travelling Fellow in 1931, and characteristically employed a sabbatical leave in 1938 as member of an expedition to the Galapagos Islands, where he studied the plant pigments of the endemic flora.

In January 1940, Dr. Taylor joined the Royal Engineers and served as technical officer on the General Staff at G.H.Q., Middle East, from July 1940 until October 1942. After a short period at G.H.Q., Home Forces, he was released from the Army to go to Washington in January 1943 as secretary (and later director) of the British Commonwealth Scientific Office, where he played a key part in the broadening of that organisation which led to its present title of "British Commonwealth Scientific Office". In March 1944, Dr. Taylor relinquished his Washington appointment to become scientific adviser to the Supreme Allied Commander, South-East Asia ; for this work, which terminated with his return to Oxford in October 1945, he was awarded the C.B E. Dr. Taylor's wide chemical interests are associated with many outside the subject : to a well-informed enthusiasm for botany, ornithology and music may be added a passion for travel that has taken him to every continent but Australasia. His adventurous spirit and zest for many branches of knowledge augur well for the future of his important task in the Caribbean area.

Botany at Sydney : Prof. N. A. Burges

DR. N. A. Burges, University demonstrator and fellow of Emmanuel College, Cambridge, has been appointed to the chair of botany in the University of Sydney, in succession to Prof. Eric Ashby. Born in Australia, he graduated at Sydney in 1931, after which he began researches in mycology. In 1934 he went to Cambridge as a research student with an Australian scholarship and carried out investigations in plant pathology. He soon showed himself to be a man of exceptional ability. He took an active part in the life of Emmanuel College and was prominent in athletics. He graduated Ph.D. in 1937 and was awarded a senior 1851 Exhibition. In the following year he was elected a research fellow of his College. Early in the War he joined the R.A.F V.R. and was attached to the signals branch of Bomber Command, retiring in 1945 with the rank of wing-commander On returning to Cambridge he was made a University demonstrator, and in addition to continuing his researches, especially on soil fungi and mycorrhiza, greatly assisted in restoring the Botany School to its peace-time activities. Dr. Burges has wide botanical interests both in the field and in the laboratory, for which he will have ample scope at Sydney. He certainly will be an inspiration to his students. His Cambridge colleagues, though personally regretting his departure, are confident that he will maintain the prestige already associated with the Sydney Department of Botany. Both the University and his native country are to be congratulated on his return.

Botany at Hull : Prof. R. D'O. Good

MR. R. D'O. GOOD, head of the Department of Botany at University College, Hull, since 1928, has been appointed to the newly created chair of botany. After serving in the Army during the First World War, Dr. Good went to Downing College, Cambridge, and took botany in Part 2 of the Natural Sciences Tripos in 1922. He was for a time an assistant in the Department of Botany at the British Museum, and while there he began the phytogeographical investigations for which he is widely known. Studies of the distribution of the Magnolieæ, the Stylidiaceæ, *Empetrum* and *Coriaria*, and a valuable summary of discontinuous generic distribution in the Angiosperms were followed by "A Theory of Plant Geography" (1931). This important analysis of the factors determining plant distribution continues after fifteen years to provide a basis for the discussion of phytogeographical principles. More recently Prof. Good has been making a detailed botanical survey of his native county, Dorset, and the publication of a small paper on the distribution of the primrose in Dorset gives cause to expect that the work, when completed, will set a ne[illegible] far higher standard for county floras. Al[illegible]s will wish Prof. Good happiness and succe[illegible] new appointment.

Physiology at Sheffield : Dr. D. H. Smyth

Dr. D. H. Smyth, senior lecturer in physiology at University College, London, has been appointed to succeed Prof. G. A. Clark in the chair of physiology at the University of Sheffield. Dr. Smyth was educated at the Royal Belfast Academical Institution and at the Queen's University, Belfast, in the Faculties of Medicine and Science, where he had a brilliant career. He has held various studentships and appointments, mainly in connexion with his subject of physiology, and has gathered wide experience as a teacher during his stay of three years at Belfast and nine years at University College, London. At the latter place he held for three years the important post of tutor to medical students, and sub-dean of the Faculty of Medical Sciences. Dr. Smyth also worked under Prof. H. Rein, at the University of Gottingen, during 1936–37. His interests in research work have been in two main directions, the first on the physiology of respiration and the reflex control of respiration from the carotid sinus, and the second on the metabolism of tissues such as the brain, heart-muscle, etc. He also carried out confidential work for the Ministry of Supply during the War. Dr. Smyth has always taken a keen interest in the general problem of medical education, and in that difficult and topical one, the selection of students for entry to the medical curriculum.

British Institution of Radio Engineers : Twenty-first Anniversary

The twenty-first anniversary of the formation of the British Institution of Radio Engineers was celebrated by a dinner at the Savoy Hotel on October 31 under the presidency of Viscount Mountbatten of Burma. The guests included several eminent men of science and engineers from the universities, the Services and Government departments. Lord Mountbatten was introduced to the assembly by Mr. Leslie McMichael, the immediate past-president, who explained that the new president had received all the education and training in wireless technology and application provided by the Royal Navy, and that in all these courses he had attained high honours and distinctions.

At the beginning of his presidential address, Lord Mountbatten announced that H.M. the King had intimated his readiness to become a patron of the Institution. He then went on to describe the manner in which, during the War, scientific men in every field had applied their knowledge and skill to the solution of practical problems and so had contributed to a very notable extent in bringing about victory. Great stimulus had been given to all forms of radio and electronic research, and much of the resulting experience is now being devoted to inventions for peace-time purposes. Lord Mountbatten gave a very imaginative and highly stimulating forecast of what might be the future of radio communication, radar, and other forms of radiation ; and, looking further ahead, visualized the possibility of the electronic calculating machine, such as ENIAC (described in *Nature* of October 12), evolving into a device which might perform functions comparable with those at present undertaken by the semi-automatic portions of the human brain. Now that the memory machine and electronic brain are upon us, it seemed that we are really facing a new revolution, not an industrial one, but a revolution of the mind ; and the responsibilities facing the scientific man to-day are formidable and serious. Following this address, the toast of the Institution was proposed by Sir Robert Robinson, president of the Royal Society.

Neighbourhood Planning in Education

The Bureau of Current Affairs, acting on behalf of the Carnegie United Kingdom Trust, has recently issued a pamphlet (No. 13) entitled "Education for What ?" written by Mr. John Mackay-Mure (London : Bureau of Current Affairs). The pamphlet deals with one of the most important sociological problems of the present time. Asking his readers to "think again", the writer puts to them the questions : What is the object of education, and what is the best way of fulfilling that object ? Then he comes to closer quarters with his purpose. Can any child's education be complete by the age of fourteen or fifteen ? Is education simply a matter of schooling ? Are our schools sufficiently integrated with home life ? What place can be found for education in neighbourhood planning ? And so we arrive eventually at the climax of the meaning and purpose of the pamphlet. Every teacher in a socially degraded neighbourhood knows too well that the school is daily fighting a losing battle with the home and the streets. There is only one way out—the way of neighbourhood planning. Planners both in Britain and in the United States have taken the neighbourhood as the social unit of their planning, the neighbourhood being defined in terms of the population that would serve a school for children between the ages of seven and eleven, thus making the junior school fundamental. This is a step towards an object which is difficult but not unattainable, an "educative community of whole men and whole women". Such is a brief outline of this significant pamphlet, the keynote of which is "educative community". The only fault we have to find with it is that the illustrations are not a successful effort at popularization.

Indian Association for the Cultivation of Science

The annual report of the Indian Association for the Cultivation of Science, Calcutta, for the year 1945 includes the report of the Committee of Management, with a list of papers published in the *Proceedings* of the Association and in the *Indian Journal of Physics*, the accounts of the Association for the year ended December 31, 1945, and budget estimates for 1946. An appended report on the scientific work of the Association by Prof. K. Banerjee refers to the continued detailed study of extra reflexion of X-rays from crystals of phloroglucinol dihydrate, benzil, *o*- and *p*-dinitrobenzene and pyrene. The intensities of the reflexion due to spatial derangement waves in general fall off very rapidly, showing that the wave-lengths of the derangement waves responsible for these extra reflexions are long. With benzil the intensities of the continuous lines due to planar derangement waves fall off gradually and much more slowly than diffuse spots. X-ray studies on jute fibres showed that methylene blue and Congo red cause no structural change in the cellulose, but complete delignification with chlorine dioxide over a long period causes partial dishevelling of the cellulose fibres, though no further change in diffraction pattern resulted on dyeing. Mercerized jute, dyed or undyed, also gives the typical mercerized cellulose pattern.

X-ray investigations on the structure of boric acid glasses containing sodium bromide, potassium bromide and potassium sulphate have continued, and all the lines in the Debye–Scherrer photographs were identified as due to the dissolved salt. The effect of various concentrations of gold and platinum dissolved in boric anhydride and borax glasses was also investigated, and other studies relating to the electrical and magnetic properties of single crystals of molybdenite indicate that along the basal plane the conductivity is wholly electronic above 90° C. Raman spectra studies have demonstrated the formation of associated molecules of ethylene dibromide and aliphatic ketones in the solid state. The spectra of di-*n*-propyl ketone shows no appreciable fluorescence at room temperature; but an intense fluorescence band at 4880–5100 A. has been observed in the solid state at − 170° C. The absorption and fluorescence spectra of anthracene have also been studied from the temperature of liquid oxygen to 100° C. Many of these investigations carried out under the auspices of the Association have been reported as "Letters to the Editors" in *Nature*.

Amateur Astronomy in Czechoslovakia

ZDENEK KOPAL has an article on this subject in *Sky and Telescope* of July, in which he discusses the development of amateur astronomy in Czechoslovakia since its beginnings in the second half of the nineteenth century. A large portion of the article is devoted to a survey of the careers of Josef and Jan Fric who, late in the last century, were among the first in Central Europe to photograph celestial objects systematically. The Ondrejov Observatory, on a hill about 1,700 ft. above sea-level and thirty miles south-east of Praha, was erected by Josef Fric as a memorial to his younger brother Jan, who died in 1897. It is interesting to know that one dome of the Observatory houses an 8-in. refractor, the lens of which was made nearly a century ago by the then unknown amateur optician, Alvan Clark. The Rev. W. R. Dawes, the well-known British amateur astronomer, purchased the lens from Clark, and after his death it was purchased by Prof. Safarik and eventually reached Praha. After the death of Safarik it came into the possession of the Fric brothers and was later mounted at Ondrejov. In 1917, the increase of astronomers in the country justified the founding of an astronomical society in Praha, and in 1928 the Czechoslovak Astronomical Society erected its own Observatory at Petrin Hill overlooking Praha. At present the membership numbers more than 2,400, and as there are only about eleven million Czechoslovaks living in Central Europe, this is probably the highest percentage of amateur astronomers in any country in the world. The article describes the activities of the Society at length, and forms very useful reading for those who are interested in the work of the amateur astronomer.

Academy of Sciences of the U.S.S.R.: Design for New Buildings

ACCORDING to the *Soviet News*, work began immediately after the War on the new headquarters in Moscow of the Academy of Sciences of the U.S.S.R. The designs were executed by the Russian architect Alexey Shchusev. A single building will house the Academy's general council, all its administrative offices, a central library for 6,000,000 volumes, and ten institutes studying the humanities. It will be erected on the right bank of the Moscow River, opposite Gorky Park and next to the Crimea Bridge. The site has an area of more than 200,000 square yards, and the main façade will be 300 yards in length. The design provides for a central building with a tower at each end, and two side blocks with semicircular entrances. The seven-storied central building, 132 ft. high, will stand upon a five-floor basement, from which a broad staircase leads down to the river. In the centre there will be an eight-columned portico 80 ft. high, supporting four pairs of Corinthian columns surmounted by a hexagonal dome. To the left of the portico will rise a 260-ft. pierced tower. The main façade will be faced with natural stone. The building will stand in a large park in which eventually the Museum of the History of the Earth and the Museum of the History of Life will be built.

British Archæology in Greece

THOUGH the British School of Archæology in Greece was necessarily closed during the German-Italian occupation, it was possible to publish during the war years two of its Annuals, representing the studies of former students. Volume 40, for 1940–45, now issued (London: Macmillan and Co., Ltd. 2 gns.), contains obituaries of former students who lost their lives in the War; studies of miniature panathenaic vases by Prof. J. D. Beazley, of some provincial black-ware workshops by Mrs. A. D. Ure, and of inscriptions from Beroea by J. M. R. Cormack; an archæological survey of the classical antiquities of Chios by D. W. S. Hunt; and a full publication by Sir John Myres of excavations in Cyprus undertaken for the Cyprus Museum, including a sanctuary site at Lefkóniko, settlement sites at Enkomi, Lampousa, and Larnaca, and a rich bronze-age cemetery at Lapithos; with notes on the 'black stone' on the site of the famous temple at Paphos (which may be the actual cult-object), on the dates and origins of Cyprioti sculpture, and on the 'rising from the sea' of Aphrodite, a remarkable natural incident, resulting from the collision of incoming and reflected waves in certain winds on a steep beach, immediately in front of the Paphian Temple.

With the restoration of more normal conditions in Greece, the British School has resumed some of its former activities. The buildings and library in Athens are unharmed, the Palace site and hostel at Knossos very little damaged; but excavation is suspended until the end of 1947, through the disorganisation of the Greek Department of Antiquities.

Verticillium Disease of the Mushroom

A USEFUL pamphlet entitled "Verticillium on Mushrooms" has recently appeared from the Midlands Group Publications (Yaxley, Peterborough, 55 pp., 1946. 5*s*. net). Fred C. Atkins, honorary secretary of the Mushroom Growers' Association, reviews the history of the disease, its symptoms and control. *Verticillium Malthousei* is the causal fungus; it may be soil-borne, or carried by flies. The best method of control appears to be fumigation of mushroom houses by formalin vapour generated by mixing potassium permanganate and 40 per cent formaldehyde. An appendix contains extracts from "Control of Mushroom Diseases and Weed Fungi" by W. S. Beach (Bull. 351, Pa. Agric. Exp. Sta., 1937). Infection by *Verticillium* is favoured by high relative humidity, and an additional measure of control lies in spraying a diseased area of the bed, after removal of the good mushrooms, with Bordeaux mixture. A further appendix is a reprint of the original paper by

W. M. Ware, which describes *V. Malthousei* as a new species (*Ann. Bot.*, 47, No. 188; Oct. 1933). This gives cultural details, thermal reactions, the results of inoculation tests, and outlines methods for the examination of diseased mushrooms for the disease. There are six excellent photographs, and the pamphlet is further enriched by a coloured plate prepared by McG. Bulloch. This shows symptoms of the soil-borne and insect-borne phases of the disease.

Commonwealth Fund Fellowships

COMMONWEALTH FUND fellowships are being awarded in 1947. These fellowships, established by the Commonwealth Fund of New York in 1918, are confined to British subjects and are tenable in the United States. Three kinds of fellowships are awarded: (1) Ordinary fellowships; (2) Service fellowships, for candidates who hold British Government appointments overseas; (3) Home Civil Service fellowships, for candidates holding appointments in the Home Civil Service None of these fellowships is open to women. There is no fixed stipend, but the emolument attached to each fellowship, which is estimated at a minimum of approximately 3,500 dollars for twelve months, is calculated to cover the full expenses of residence, study and travel in the United States during the year. All applications must be submitted on the prescribed form, and must be approved by the authorities of the college or university of which the candidate is, or has been, a member. They must reach the Secretary to the Committee, Richard H. Simpson, Commonwealth Fund Fellowships, 35 Portman Square, London, W.1, by February 1, 1947.

Ministry of Agriculture Post-graduate Scholarships

THE Ministry of Agriculture has awarded the following post-graduate research and training scholarships in agricultural economics, agricultural engineering and husbandry, tenable for periods up to three years, in the first instance at the institutions shown: *Agricultural Economics:* A. W. Ashby, School of Agriculture, Cambridge; R. D. Hewlett, Department of Agriculture and Horticulture, University of Reading; O. T. W. Price (not yet determined); Miss M. A. Wilson, School of Rural Economy, Oxford. *Agricultural Engineering:* J. A. Gibb (not yet determined). *Husbandry:* G. E. Barnsley, Norfolk Agricultural Station, Sprowston; A. Mitchell, School of Agriculture, Cambridge; D. E. Tribe, Rowett Research Institute, Aberdeen.

Royal Society of Edinburgh

THE following have been elected officers of the Royal Society of Edinburgh: *President*, Sir W. Wright Smith; *Vice-Presidents*, Prof. R. J. D. Graham, Lord Cooper, Prof. J. W. Heslop Harrison, Prof. W. M. H. Greaves, Lieut.-Colonel W. F. Harvey, Prof. J. P. Kendall; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Prof. E. T. Copson and Prof. A. Holmes; *Treasurer*, Sir E. Maclagan Wedderburn; *Curator*, Dr. J. E. Mackenzie; *Councillors*, Prof. T. Alty, Mr. J. Morrison Caie, Sir Robert Muir, Lord Birnam, Prof. E. P. Cathcart, Prof. Alexander Gray, Dr. J. Russell Greig, Dr. W. A. Harwood, Prof. C. M. Yonge, Prof. A. D. Hobson, Dr. W. O. Kermack, Dr. John Weir.

The Dr. W. S. Bruce Memorial Prize (1946) has been awarded by the Joint Committee of the Royal Physical Society, the Royal Scottish Geographical Society and the Royal Society of Edinburgh to Lieut.-Colonel P. D. Baird for his valuable survey and geological work with Mr. J. M. Wordie in North-West Greenland and Baffin Island in 1934, and with Mr. T. H. Manning's British Canadian Arctic Expedition in 1936–37; during 1938–39 he went back again with his friend Bray and reached Igloolik near Fury and Hecla Strait that summer Bray was unfortunately drowned, but Baird carried on by himself and travelled extensively over northern Baffin Island, mapping as he went, and made a first entry into Bylot Island. Recently, he has been in charge of the 'Musk-Ox Operation' in Arctic Canada.

Announcements

DR. HAROLD JEFFREYS, reader in geophysics in the University of Cambridge, has been elected to the Plumian professorship of astronomy and experimental philosophy at Cambridge, vacant since the death of Sir Arthur Eddington.

DR. H. ZANSTRA has been appointed director of the Astronomical Institute of the University of Amsterdam, in succession to Prof. A. Pannekoek, who has retired.

DR. HOWARD REID CRAIG has been appointed director of the New York Academy of Medicine in succession to Dr. Herbert B. Wilcox, who has resigned. Dr. Craig was born in 1894, and since 1921 has been associated with Babies' Hospital, New York; he has served on the Advisory Council of the Child Welfare Bureau of the U.S. Department of Health

THE trustees of the Miners' Welfare National Scholarship Scheme invite applications for a limited number of university scholarships for award in 1947. There are, in addition, a limited number of exhibitions available for award to the most meritorious of the unsuccessful candidates for scholarships. Candidates must be either workers in or about coal mines in Great Britain, or sons and daughters of such workers, and should not normally be less than seventeen years of age on January 25, 1947. Forms of application can be obtained from the Secretary, Miners' Welfare National Scholarship Scheme, Ashley Court, Ashtead, Surrey. Applicants for forms must state whether they apply as workers in or about mines or as children of such workers. Completed forms must be returned by January 25, 1947.

MESSRS. EASIBIND LTD., Pilot House, Mallow Street, London, E.C.1, have sent for examination an example of the covers they supply for filing or binding periodicals. The covers are made to fit specific journals, and that for *Nature* holds twenty-six issues. Each issue is kept in place by a stiff wire the ends of which run in slots in two metal frames at the back edge of the binder; and the issues are held together by two stouter wires passing outside the first and last issues and inserted in holes in the same frames. The binder is easy and convenient to use whether full or only partially full.

ERRATUM. Dr. P. J. G. Mann and Dr. J. H. Quastel write: "The equation, relating to the decomposition of manganese dioxide by hydroxylamine, mentioned in our article on 'Manganese Metabolism in Soil' (*Nature*, August 3, p. 154) was by an oversight incorrectly stated. The equation should read:

$$2MnO_2 + 2NH_2OH = 2MnO + N_2O + 3H_2O.$$

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Fruit-setting Hormone from Apple Seeds

IN the apple, fruit size and shape are known to be closely correlated with the number and position of the fertile seeds, an observation which suggests that the developing seed may be the source of a hormone which initiates and controls the growth of the fruit. Experimental evidence supporting this has recently been obtained for the apple variety Crawley Beauty, from the young seeds of which it has been found possible to prepare extracts which are active in stimulating the development of unfertilized tomato ovaries.

Active extracts can be obtained from both fresh and dried material by the simple expedient of boiling the seeds in water (25 ml. per gm. dry wt.) in an open beaker for 15 minutes, which serves not only to extract the hormone and concentrate the extract, but also at the same time inactivates oxidizing enzymes. After separation from the plant material, the resulting liquor is cooled at 5° C. for 24 hours, filtered, and the filtrate tested directly by placing one drop on the ovary of an emasculated tomato flower Alternatively, the active principle can be removed from the filtrate by shaking with ether, evaporating to dryness, and taking up the residue with water or lanolin. If the extract is active, the tomato ovaries show visible swelling within four or five days, and eventually develop into seedless fruits of excellent size and quality.

Using the above extraction procedure, active extracts were prepared from seeds taken from young fruits collected at various stages from three to ten weeks after petal fall, but no fructigenic activity could be detected in seeds taken from fruits which were older than this. This disappearance of activity corresponded closely with the cessation of the rapid growth of the seed, the disappearance of an unidentified compound (believed to be a glucoside) from the seed, and the occurrence of the so-called 'June drop', which in this variety occurs in the latter half of July. Further work is in progress to establish more precisely the relationship between these phenomena and to investigate the role of this hormone in the processes of fruit-set and development of the apple and other tree fruits.

LEONARD C. LUCKWILL
Long Ashton Research Station,
University of Bristol.
Oct. 5.

Underground Spread of Potato Virus X

ALTHOUGH potato virus X is the most widely distributed of the potato viruses, there is considerable uncertainty about its method of transmission. No insect has been found to act as a vector, and the only way in which it is known to spread is by contact between healthy and infected plants. This was first demonstrated by Loughnane and Murphy[1,2], who concluded that it resulted solely from leaf contact, and that there was no danger of spread occurring below ground. Experiments at Rothamsted have confirmed that spread occurs only when plants are in contact and that leaf contact alone is sufficient ; but the results also suggest that root contact is equally important.

In potatoes, the rate of spread is slow ; in no year during the course of these experiments have more than 1 in 10 of the healthy plants in contact with infected ones become infected. In field experiments it has been noticed that tubers from plants adjacent to infected ones were sometimes infected even when the haulms had not reacted when tested for virus X at the end of the season. One explanation for this would be that infection occurred through foliage late in the season, and that the virus passed to the tubers without becoming systemically established in the haulms. It seemed, however, equally probable that spread was occurring underground, and glasshouse experiments were made to test this possibility.

Various experiments have been carried out in which healthy and infected potato tubers were planted in the same pots, in half of which screens of 'Cellophane' were erected to prevent foliage contact. There was too little spread for any definite conclusions to be reached, but again there was a suggestion of spread without leaf contact. In one experiment, for example, there was no sign of spread from tests made from the haulms at the end of the season in either the screened or unscreened pots, but subsequent tests on the harvested tubers showed that spread had occurred in one of the screened pots

Tomato is much more susceptible than potato to infection by virus X, and spread is much more rapid. Parallel experiments with this plant have shown that spread occurs equally well whether there is root contact only, or both root and leaf contact between infected and healthy plants. The virus strain used produced a bright yellow interveinal mottle in the tomato. Plants were set out in pairs in large pots, individual 'Cellophane' screens were erected in half the pots, and the plants were allowed to grow to 5–6 in. in height before one of them was inoculated with the virus. Tests made eight weeks later showed that 7–9 of the uninoculated plants in the unscreened pots had become infected, and 5–9 in the screened pots.

In an experiment with a different type of screen which provided a continuous barrier between the infected and healthy plants in 9 of the 18 pots, spread of virus occurred to all 9 of the uninoculated plants (root contact only) and to 7–9 of the unscreened pots. All the control tomato plants in the same glasshouse, not in contact with infected plants, remained healthy. There is no evidence to show whether the underground spread is caused by mechanical transfer of virus between roots in contact or by some other mechanism.

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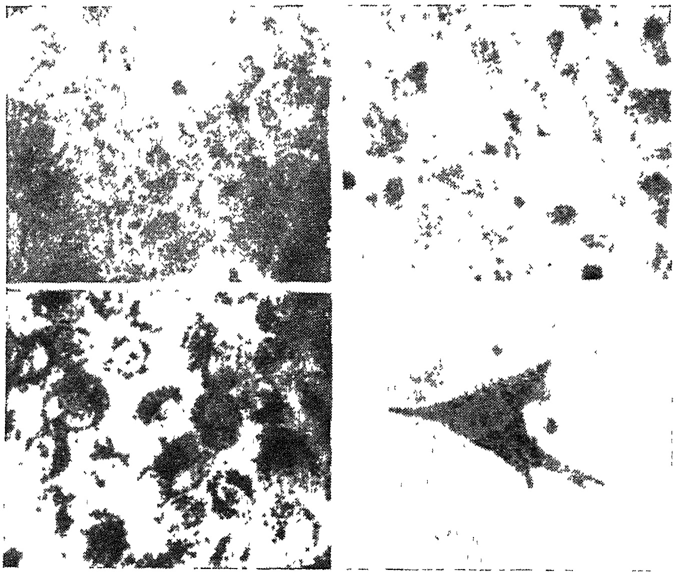
Ultra-Violet Absorption in Living and Dead Cells

AN ultra-violet microscope having an achromatic objective designed by Brumberg and Gershgorin[1] (with an aperture of 0·5) has been used for photographing living tissue cultures. The latter were grown by the hanging drop method on a quartz cover-glass. The source of light used was a high-pressure quartz



A, LIVING CANCER CELLS IN TISSUE CULTURE; *B*, THE SAME CELLS DEAD IN HYPOTONIC RINGER SOLUTION; *C*, LIVING CANCER CELLS; AND *D*, A LIVING MOUSE FIBROBLAST WITH NEUTRAL RED GRANULES. THE PHOTOGRAPHS WERE TAKEN WITH AN ACHROMATIC REFLECTING OBJECTIVE (APERTURE 0·5) IN ULTRA-VIOLET LIGHT λ 254–275 Mμ

mercury lamp. All radiation except that of wave-lengths 254–275 $\mu\mu$ were prevented from reaching the object by means of filters (bromine and chlorine vapours and Corning's Red Purple Corex A, No. 986 Glass). Focusing was performed under conditions of visible light (usually in a dark field) which completely prevented the ultra-violet rays from reaching the cells previous to their being photographed. The time of exposure was 20 sec.

Photographs of the living cells of mouse mammary carcinoma cultures, as well as of mouse or chicken fibroblasts, revealed a picture widely different from that described by Caspersson[2] both for fixed histological preparations and for living cells. In our experiments the nuclei of living cells entirely failed to absorb any ultra-violet rays within the region 254–275 $\mu\mu$ (*A*). The nucleoli alone revealed moderate absorption. Cancer cell cytoplasm was likewise found to absorb ultra-violet rays moderately.

With the view of checking their state of vitality, some of the cultures were immersed, previous to their being photographed, in a solution of vital stain, namely, neutral red, in Ringer's mixture. The granules of the stain which intensely absorbed ultra-violet rays in the cytoplasm formed a clear demarcation around the nucleus which, however, with the exception of the nucleoli, failed to reveal any ultra-violet absorption (*C* and *D*). Whereas the cytoplasm of non-stained cancer cells absorbed ultra-violet rays, the cytoplasm of vitally stained cells lost its capacity for absorption, which was centred in the granules.

Ultra-violet radiation of the culture on the microscope stage for two minutes (without the use of filters) was found to effect typical changes. The nucleus developed the capacity for ultra-violet absorption, the nuclear membrane became clearly outlined, and the nucleoli developed more intense absorption. As a result the cell nuclei revealed the same picture as that described in Caspersson's investigations. So far we have failed to obtain more detailed photographs of nuclear structure owing to the aperture of the objective not being sufficiently large. When radiation wave-length 313 $\mu\mu$ was used (the filter being a solution in water of potassium chromate and 'Corax' glass) no ultra-violet absorption was observed. Together with a change of ultra-violet absorption occurring in the nuclei, they became smaller in size, their diameter being reduced by a quarter or a third. Cancer cell cytoplasm lost its capacity for absorption, owing to which fact its fatty-lipoid inclusions were clearly outlined. In the experiments conducted with neutral red stain the granules of the latter were found to disappear at the onset of the injury.

Similar changes in ultra-violet absorption were observed when the cells were dying in a strong hypotonic solution, (*B*), or due to mechanical factors. Photographs taken in succession revealed the gradual course of these processes; details are given elsewhere[3].

In Caspersson's investigations the cells of the nuclei which were to be examined *in vivo* were apparently found to absorb ultra-violet rays owing to the fact that, since he was using a monochromatic objective, Caspersson was obliged to take a few preliminary photographs in ultra-violet light with the view of getting the object in focus, and the cells were damaged and killed in the process.

Apparently desoxyribonucleic acid is contained in the nuclei of living cells in a somewhat different state, in which it does not absorb ultra-violet rays of wave-length about 260 $\mu\mu$. Absorption develops in connexion with the injury and death of the cells.

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Quantitative Microchemical and Histochemical Analysis of Elements by X-rays

A METHOD of X-ray absorption analysis has been developed which permits the quantitative determination of elements with low atomic numbers in extremely small quantities of a biological tissue. It is based upon the measurement of the absorption of monochromatic X-ray radiation, within a very small area of an object, for example, a microscopic section of a tissue. The measuring procedure, either ionometrically or photographic-photometrically, is repeated in a series of wave-lengths lying on each side of a long-wave X-ray absorption edge of the element sought for. From these experimental data the quantity of the element in question can be calculated. Localization of the area in the specimen to be analysed is secured by taking monochromatic X-ray radio-micrographs. The method permits of the determination in a tissue of elements of atomic number above 6. Thus with the exception of hydrogen, all elements of biological interest can be determined. Analysis may be made upon a volume of tissue corresponding to that of a mammalian cell. In analyses of calcium and phosphorus in biological material, quantities of 10^{-10}–10^{-11} gm. have been determined by the method with an error of 10 per cent.

A complete theoretical investigation of the method of analysis, a description of the construction of the experimental apparatus and an account of the analytical technique and the experimental results obtained will shortly be published in a supplement to *Acta Radiologica* (Stockholm).

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Role of Ultra-filtration in the Formation of Aqueous Humor

IN a previous communication[1], I reported that sodium enters the aqueous humor predominantly by secretion. This implies either : (i) that practically no ultra-filtration at all takes place from the vessels of the iris and ciliary body ; or (ii) that the amount of sodium entering the aqueous by secretion greatly exceeds the amount entering by ultra-filtration, even if ultra-filtration still supplies a considerable part of the fluid volume of the aqueous.

If alternative (i) were true, the old question of the relative importance of ultra-filtration and secretion in aqueous humor formation would be solved. If alternative (ii) were true, the problem would still be unsolved. The present work was undertaken to test alternative (ii).

If the secretion is to supply almost all the sodium and the ultra-filtrate a considerable part of all the fluid, their respective sodium contents obviously must be markedly different. But as sodium is the absolutely dominant cation of the aqueous, a marked difference in osmotic pressure would necessarily accompany any large difference in sodium content. If alternative (ii) were true, then the secretion would have a higher osmotic pressure than the ultra-filtrate. The aqueous, being a mixture of the two, would have an intermediate osmotic pressure, and this would depend on the proportions of the mixture. Thus, by reducing the amount of ultra-filtrate, one could change the osmotic pressure of the aqueous towards that of the secretion and, as the secretion is hypertonic, towards higher values of osmotic pressure.

The amount of ultra-filtrate (if any) in the aqueous of one eye was reduced by clamping the homolateral common carotid artery in rabbits. This greatly reduced the filtering pressure and thereby the rate of ultra-filtration. The osmotic pressure difference between the two aqueous humors was determined by the Hill–Baldes thermo-electric method 1·5–2 hours after carotid closure. The mean difference between the side with closed carotid and the control side was $-0·5 \pm 1·1$ mgm. sodium chloride per 100 ml. (29 experiments on 22 animals, 3–9 determinations of osmotic pressure on each sample). Thus, the blood pressure reduction cannot have augmented the osmotic pressure by more than at most $-0·5 + 3 \times 1·1 = 2·8$ mgm. sodium chloride per 100 ml. or about 3·2/1,000 of the total osmotic pressure. This change is so small that ultra-filtration cannot play any considerable part in the formation of aqueous humor.

A full account of the experiments contained in this and the previous communication will appear in *Acta Physiologica Scandinavica*. A series of papers dealing with the pressure relations after unilateral carotid closure is in the press in *Acta Ophthalmologica*.

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[1] *Nature*, 157, 770 (1946).

Role of the Earthworm Nephridium in Water Balance

OSMOTIC and volume regulation have been studied in the earthworm *Lumbricus terrestris* by many investigators, but no very convincing evidence has been presented regarding the part played by the nephridia. Overton[1] observed an initial loss of weight on handling the worm, and attributed this to the expulsion of fluid through the nephridiopores ; but Adolf[2] failed to confirm this and concluded that there was "no evidence that the nephridia are at all concerned in the water exchange of earthworms". Since then, Maluf[3] has confirmed Overton's observation and has brought indirect evidence to suggest that the urine is hypotonic to the body fluids. Still more recently, Bahl[4], working on *Pheretima*, collected urine by draining from forty to fifty worms in a glass vessel, and showed that the fluid obtained in this way was hypotonic to the cœlomic fluid.

The purpose of this communication is to state that it has recently been found possible to collect urine directly from a single nephridiopore, by inserting a fine pipette, in sufficient quantity for vapour pressure determination by the Hill–Baldes method. Previous to the experiment, the worm (*L. terrestris*) is kept for some days in tap water, and during the process of collection, which takes two to three hours, it is pinned down in a moist chamber. Since the orifice of the pipette is readily blocked with mucus, etc., only a limited proportion of attempts are successful, but results have been obtained as follows, osmotic pressure being expressed in terms of the equivalent concentration of sodium chloride per cent.

Experiment	Cœlomic fluid	Urine
1	not recorded	0·10 0·12
2	0·41	0·06 0·05
3	0 65	0 19 0 14
4	0 52	0·08

These results, although thus limited, are sufficiently clear-cut to indicate that the urine is strongly hypotonic to the cœlomic fluid, which implies that the nephridia have an active role in water balance.

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Chromosome Number of *Rorippa (Nasturtium) sylvestris*

THE only published count of the chromosome number of *Rorippa sylvestris* (L.) Besser (= *Nasturtium sylvestre* (L.)R.Br.) appears to be that of Manton[1], who found $2n = 32$. In a search for the other parent species which, with *Nasturtium officinale*, has given rise to the allotetraploid species *N. uniseriatum*[2], I studied a specimen of *R. sylvestris* obtained from the Newry canal at Newry (border of Co. Down and Co. Armagh, N. Ireland) and found this plant to have a chromosome number of $n = 24$ and $2n = 48$. Similarly, specimens of *R. sylvestris* from Horton-in-Ribblesdale (Yorkshire) and from the Botanic Gardens at Cambridge and Kew (the plant was growing as a weed in both gardens) were all found to have a chromosome number of $n = 24$. There thus seems no doubt that British specimens of *R. sylvestris* have a chromosome number of $2n = 48$ and not $2n = 32$ as reported by Manton.

Prof. Manton obtained her specimen of *R. sylvestris* as seeds labelled *Nasturtium lippizense* from the Munich Botanic Gardens. There is a single sheet of the plant of which the chromosome number was counted by Manton in the University of Manchester Herbarium. Unfortunately, it has no fruits, and the separate fruits which have also been preserved are not adequate for determining whether Manton's plant really was *R. sylvestris*. Also *N. lippizense* is listed as a distinct species in the Kew Index, and is not a synonym for *N. sylvestre*. It is thus possible that Manton's count does not refer to *R. sylvestris*, but to the European species *N. lippizense*.

Both the cuttings of the single plant from Newry and the clone of *R. sylvestris* growing in the Cambridge Botanic Gardens produced no seeds by natural pollination. A high set of good seeds was, however, obtained by bud pollination or by crossing the Newry and Cambridge plants. It thus seems that *R. sylvestris* is self-incompatible. This is rather unexpected in a hexaploid species, the basic chromosome number in the genus *Rorippa* being 8.

My thanks are due to Mr. C. A. Cheetham, Mr. H. Gilbert Carter and Mr. N. Y. Sandwith for specimens, and to Mr. V. Chapman for making the cytological preparations.

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Amniotic Inoculation of Chick Embryos

THE respiratory tract of the developing chick embryo is susceptible to infection with various bacteria and the viruses of influenza, psittacosis, herpes and certain other infections of man and animals. This infection of the respiratory system is secured most readily by an inoculation of the virus directly into the amniotic cavity. Various techniques have been devised for this purpose, by Goodpasture, Hirst and others, but the most popular is probably that of Burnet[1]. By this method, virus is inoculated under direct vision into the amniotic cavity, which seems preferable to methods where the inoculation is made 'blind'.

In the course of studies on the reaction of the respiratory system to amniotic inoculation of influenza virus (to be published), it was discovered that Burnet's method could be simplified. The method that I have used seems to be such an obvious modification of Burnet's technique that doubtless other workers have come to use a similar method, but I have not seen any references to the use of such a procedure. I have decided to publish this note as there seems to be an impression that amniotic inoculation is difficult; but this need not be so, and the technique deserves wider application in experimental work.

Eggs of 13–14 days are candled, and the site of the densest area of the embryo marked with a pencilled cross. An equilateral triangle, with sides about 1 cm., is then drilled in the shell with a rotating disk, operated by a foot or electrically-driven dental drill. The shell in this area is then lightly dabbed with methylated spirit, and when this has dried, the triangle is gently levered off with a mounted dissecting needle sterilized by flaming. The shell membrane is now exposed, and should be undamaged. A drop of sterile saline is then placed on the shell membrane and a small opening made with a dissecting needle. The drop is coaxed to run under the shell membrane to separate it from the underlying vascular, easily damaged, chorio-allantois. A pair of delicate forceps, without teeth, is then used to tear away gently the triangular area of shell membrane. This can easily be done without damaging the chorio-allantois, especially as it is usually found that by this time it has dropped down some little distance. A heated dissecting needle is now used to make a small 'nick' in the chorio-allantois. The heated needle will make a short tear, and at the same time seal any opened vessels, thus minimizing bleeding.

A pair of sterile fine curved forceps is now passed through the tear in the chorio-allantois. The forceps are then opened and the underlying amnion grasped and pulled through the tear. The inoculation is then made into the amniotic cavity through a delicate short-bevelled needle attached to a 1 c.c. syringe held in the other hand. On completion, the amnion slips back into place. Sometimes, especially in older embryos, the embryo can easily be seen under the chorio-allantois as soon as the shell membrane is reflected. If so, it is not necessary to cut the chorio-allantois, as the inoculation can be made simply by passing the needle through the chorio-allantois and amnion into the amniotic cavity.

The triangle in the shell is then ringed round with a mixture of molten 'Vaseline' (with a little added hard paraffin) applied by a pasteur pipette. A sterile coverslip is quickly flamed and applied to the 'wall' of 'Vaseline'. Before placing in the incubator, the egg should be held level with the eye, to make certain that there is no gap in the 'Vaseline' ring. The embryo should be observed daily, and if still alive vigorous movements will be seen.

The only important modification in this method is that I do not find it necessary to 'drop' the chorio-allantois artificially by applying suction to a hole in the air-sac end of the egg.

Various authors who have used amniotic inoculation speak of a mortality-rate in the embryo, from the effects of the inoculation *per se*, of 30–40 per cent. I have not yet inoculated sufficient embryos to give a definite figure, but I have on a number of occasions inoculated a batch of up to six with sterile broth, and found most to survive in a healthy state for many days, suggesting a lower rate of mortality.

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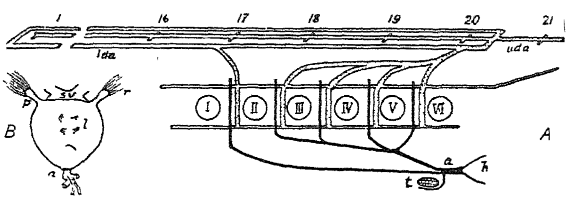
A Living Bony Fish which Differs Substantially from all Living and Fossil Osteichthyes

IN 1883, Gill and Ryder[1] stated that *Eurypharynx* (order Lyomeri) has *six* branchial clefts and *five* holobranchs, a feature found in some Selachians but never in Osteichthyes. However, the nature of this extra cleft and gill was uncertain, and the very fact of their presence was considered doubtful. Through the kindness of Dr. Å. V. Tåning, of the Marine Laboratory, in Charlottenlund Slot, I received a number of specimens of *Eurypharynx*. All the *Eurypharynx* which I have examined invariably have *six* branchial clefts and *five* holobranchs.

Eurypharynx has true bones with cells. The dorsal end of the hyomandibula articulates with the auditory capsule laterally to the head vein (characters of Osteichthyes). But in contrast with Osteichthyes, there are no opercular bones and there is no secondary upper jaw (premaxilla and maxilla). The dorsal element of the mandibular arch consists of two bones, the quadrate articulating directly with the ventral end of the hyomandibula, and another bone acting as the upper jaw. The latter bone is closely united with the suspensorium, its posterior end being attached to the inner side of the quadrate; it lies medially to the m. adductor mandibulæ. Thus, this bone corresponds apparently to the pterygoid and the palatine.

The hyoid arch consists of a single element, the hyomandibula; there is no symplectic and no trace of the ventral hyoid elements.



(*A*) DIAGRAM OF THE BRANCHIAL REGION OF THE ARTERIAL SYSTEM OF *Eurypharynx*, LEFT SIDE, SLIGHTLY FROM ABOVE Afferent arteries black, efferent arteries dotted. I–VI, branchial clefts; 1–20, segments of the body (segments 2–15 not shown in the figure), *a*, ventral aorta, *h*, bulbus aortæ · *lda*, lateral dorsal aorta (paired), *t*, thyroid; *uda*, unpaired dorsal aorta

(*B*) PERICARDIUM OF *Eurypharynx* WITH THE PECTORAL FINS ATTACHED TO IT VENTRAL VIEW, DIAGRAMMATIC *a*, ventral aorta; *l* ligaments attaching the ventral muscle of the body to the pericardium; *p*, lobes of the pectoral fins; *r*, fin rays; *sv*, sinus venosus

Cephalic nerves. The hyoid branch of the facial nerve does not extend behind the foremost branchial cleft. The glossopharyngeal nerve runs into the septum dividing this cleft from the second one. Branches of the n. vagus pass behind the second, third, fourth, fifth and sixth branchial clefts. Thus, the foremost cleft corresponds to the first branchial cleft and the posterior branchial cleft is an extra one, homologous to that found in some Selachians.

Vascular system. The ventral aorta is short. It divides vertically into three short trunks from which issue six pairs of afferent arteries. The most ventral pair supplies with blood the thyroid gland and the ventral muscle of the body; the next five pairs are the branchial afferent arteries.

The efferent branchial arteries are united above and below the branchial clefts by lateral commissural vessels forming vascular loops round the second, third, fourth and fifth branchial clefts. In this respect *Eurypharynx* recalls Selachians rather than Osteichthyes.

Beside the lateral dorsal aortæ, which unite anteriorly forming the circulus cephalicus, an anterior unpaired dorsal aorta extends from the hind end of the branchial region to the cranium; it runs between the left and right lateral dorsal aortæ, and gives off twenty pairs of inter-segmental arteries. Such a structure is not found in Osteichthyes; it recalls rather the condition of *Myxine* and Selachian embryos[2].

The branchial clefts of *Eurypharynx* are surrounded by muscular sphincters.

The pericardium of *Eurypharynx* is very thick and has an unusual relation to the pectoral fins These fins are small with lobate basal parts. The basal parts extend inwards and forwards, pass through the septum dividing the cœlom of the body from the heart and unite firmly with the posterior ventral edge of the pericardium. The elastic fibrillæ of the pericardial wall pass right into the lobes of the fins. In supporting the pectorals the pericardium acts as the shoulder girdle. The pectoral fins are small, but functional, for their muscles are well developed; thus the movements of these fins probably affect the working of the heart The relations between the pericardium and the pectorals of *Eurypharynx* appear to be unique among fishes.

Only some of the features of *Eurypharynx* are mentioned here, but even these brief characteristics show that it disagrees most substantially with other bony fishes (Osteichthyes).

There seems no reason to consider these unusual features as merely modifications due to unusual surroundings and habits. The Lyomeri live in the same milieu as many other deep-sea fishes, feed upon similar food, and struggle against the same enemies. They are large fishes (some up to 6 ft. long), and are widely distributed over the deep parts of the seas. Two families of Lyomeri are known: Eurypharyngidæ and Saccopharyngidæ, the latter with several species. Thus one can scarcely consider profound differences between Lyomeri and other Osteichthyes as mere secondary adaptations having no phylogenetic importance. The problems mentioned will be dealt with fully elsewhere.

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Ecdysis and Growth in Crustacea

THE restriction of increase of size to the immediate post-ecdysal period is a feature of growth peculiar to Arthropods. The rapidity of the increment suggests that it is due merely to inflation of the body with fluid[1,2,3], while true growth, that is, the addition of new protoplasm and cell division, is probably continuous as in other groups. There remains the question. Does the post-ecdysal inflation affect the cavities of the body, the tissues, or both?

The phenomenon has been studied histologically on *Asellus aquaticus*, the habit of moulting of which in two stages enables fixation of individuals when the posterior half of the body has already undergone ecdysis and the subsequent increase in size, whereas the anterior half is still in the pre-ecdysal stage. From longitudinal, particularly frontal, sections, the pre- and post-ecdysal histology of the metamerically homologous body-segments may be compared synoptically, after identical technical treatment. Some twenty preparations were studied at various stages of the 'intramoult' period.

In addition to general observation, the following data were compared in the pre- and post-ecdysal regions: (1) number of cells per unit extent of the epidermis; (2) dimensions of corresponding structures, from total body width and depth to particular cells and their nuclei; and (3) relative size of the hæmolymph, and other, cavities. Representative results are shown in the accompanying table.

	No. 1		No 2	
	Pre-ecdysal	Post-ecdysal	Pre-ecdysal	Post-ecdysal
No. of cells per 40 unit extent of epidermis	9·7 (10)	7·8 (8)	8·0 (10)	7 3 (8)
Thickness of epidermis	4 4 (11)	7 7 (10)	8·6 (5)	11 9 (5)
Thickness of sarcoplasm of main muscles of limb-base	10·7 (14)	11·8 (14)	14·7 (6)	16·2 (6)
Total thickness of these muscles	41 4 (9)	82 0 (5)	—	—
Max diam. of nuclei of epidermal cells	—	—	3·5 (42)	3 8 (34)
Max. diam. of nuclei of muscles	4 6 (15)	4·5 (24)	3·9 (15)	4·3 (16)
Max diam of nuclei of cells of hind-gut	15·4 (11)	13 2 (8)	19·0 (16)	16 1 (14)
Max. diam of nuclei of cells of digestive diverticula	—	—	17·7 (12)	17 5 (11)

The figures, in units (mm. × 3^0), are averages the number of observations being shown in brackets.

There was no evidence of mitosis during ecdysis. The number of cells per unit extent of the epidermis actually decreased (see table), and the classical view of a simple inflation with fluid is no doubt correct. Under optimum conditions there was an approximation to the two-fold increase in total volume required by the Brooks–Przibram law[4].

The inflation affects not only the hæmolymph and all cavities, including intercellular spaces, but also the cells and tissues themselves (for example, epidermis and muscle). This is shown also by a marked decrease in the density of staining of the tissues, and by an evidently wider spacing of the muscle fibres and increased vacuolation of the cytoplasm. There was no measurable increase in cell-size in the hind gut, the digestive diverticula and the ovary, which extend through both pre- and post-ecdysal regions, though the cavities of the two former organs increased. There appeared to be no significant increase in size of the nuclei of any tissues; unfortunately the nuclei of those tissues (epidermis and muscle) which showed a clear cellular enlargement are not large enough (10 μ) for accurate measurement, even with the oil immersion objective. The smaller size of rectal nuclei in the posterior half of the body may be an intrinsic local difference.

Towards the onset of ecdysis, the epidermal cells become filled with ovoid inclusions which may be material resorbed from the inner layers of the old exoskeleton[1]. Their staining reaction, with Heidenhain's Azan, seems to change from blue to red with the progress of resorption. This is probably a genuine change, and not an effect of slight variations in technique, since the pre-ecdysal tissue (muscle in particular) is usually bluer than the post-ecdysal, under identical treatment. The inclusions disappear rapidly after ecdysis, and it seems probable that their solution may assist the post-ecdysal inflation by increasing the osmotic pressure within the body.

In the pre-ecdysal anterior half of the body, after the ecdysis of the posterior half, water would tend to flow into the space formed, by resorption, underneath the old exoskeleton; but this is prevented by light adhesion of the latter, around its free posterior margin, to the new exoskeleton forming below.

In ecdysis, any available rough surface is used to anchor the dactyl-claws of the walking legs and facilitate withdrawal from the exoskeleton, but the animal emerges successfully on a smooth glass substratum. The barb-like orientation of the free ends of most of the setæ towards the distal ends of the limbs and of the abdominal plate ensures that the tissues can move only in a proximal direction relative to the exoskeleton. By unco-ordinated muscular activity the various parts are thus in turn drawn a little farther from the exuvia. The total diminution in volume of the soft parts during the process of withdrawal is very considerable; in old or pathological individuals the post-ecdysal increase is not always sufficient to restore the volume, and 'degrowth' may be said to occur. The soft parts are remarkably plastic, the broad flat abdominal plate passing quickly and easily through the round narrow 'waist' and then rapidly recovering its normal shape. The new exoskeleton hardens within 1–3 hours. Ecdysis rarely occurs except in the early morning.

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Geomagnetic Control of Region F_2 of the Ionosphere

In a recent communication in *Nature*, Sir Edward Appleton[1] has brought forward unmistakable evidence of geomagnetic control of the distribution of ionization in the F_2 layer. In particular, he has shown from an examination of the world data that, "for noon equinox conditions, there is a belt of low values of f_{F_2} circling the earth and centred roughly on the magnetic equator". The geomagnetic control raises the important question of the nature of the source of the control. Since magnetic disturbances and auroras are also subject to similar control, one can envisage, in common with the probable origins of these geophysical phenomena, two possible sources:

(1) It may be imagined that part at least of the F_2 ionization is produced by bombardment of the upper atmosphere by charged particles (after the Birkeland–Stormer hypothesis of auroras and magnetic disturbances). Further, since the points of precipitation of these particles are controlled by the terrestrial magnetic field, the geomagnetic control of F_2 layer ionization is understood. This, however, raises the old difficulty of the speeds of such particles; in order to reach low latitudes they must possess velocities approaching that of light. Such energetic particles are too penetrating to ionize atmospheric gases in the F_2 region.

(2) The above difficulty is avoided if one makes the plausible assumption that the charged particles are of terrestrial origin (after the ultra-violet light theory[2] of auroras and magnetic storms). In the region high above the F_2 layer where the fringe of the atmosphere might be supposed to begin, the collisional frequency is very small and the electrons and ions produced by solar ultra-violet rays have very long free paths. They are thus free to spiral round the magnetic lines of force and, at the same time, are roughly guided along them, because, when formed by photon absorption, they will in general have velocity components along the lines of force. Now, at the magnetic equator the lines of force rise highest and slope north and south. The ions and electrons formed in the high atmosphere in the belt along the magnetic equator are therefore guided north and south and, when they come down to the lower levels, contribute to the ionization density of Region F_2. The densities on either side of the magnetic equator are thus increased by this 'distilling' process which operates throughout the daylight hours.

It should be mentioned at this point that the 'ultra-violet light theory' fails to explain the auroral phenomena, because, as was pointed out by Chapman[3], the lines of force which enter the terrestrial atmosphere near the auroral belt rise to 30,000–40,000 km. at the magnetic equator. At such heights, there being no atmosphere, the necessary charged particles cannot be formed. But, as is shown below, the theory can be adapted to explain the observed geomagnetic control of the F_2 region.

From Fig. 2 of Appleton's note, it is seen that the peaks on either sides of the magnetic equator lie in the region of magnetic dip value of about 28°. The geomagnetic lines of force which enter the earth's atmosphere in this region (dip value 19°–34°) at 400 km. level rise to heights of 600–1,200 km. over the magnetic equator. It therefore follows that if, (1) there are atmospheric particles in sufficient numbers at such heights, and (2) these particles are ionized by solar ultra-violet rays, then the ions and electrons so formed will be guided to the regions of the observed peaks of Appleton's curve. Now, direct evidence on these two points is furnished by the sunlit auroras[4]. The fact that these auroras are observed at heights of 600–1,100 km. is evidence that there are sufficient atmospheric particles at such heights. The proof of ionization by solar radiation is furnished by their spectrum, in which the first negative bands, due to N_2^+, are greatly enhanced.

In the illustrative example, the 400-km. level has been taken as the level of entry of charged particles into the atmosphere. This is because at about this level the collisional frequency begins to be sufficiently high to prevent the particles from freely following the magnetic lines of force. Assuming the atmospheric density in Region F_2 (250-km.) level to be 10^{10}/c.c., the collisional frequency of electrons 10^3/sec. and a rising temperature of 4° K./km. above (all as indicated by radio observations[5,6]), the densities at the 400-km. and the 600-km. levels are found to be of the orders of 3×10^8 and 2×10^7/c.c. and the collisional frequencies 30 and 2 per sec. respectively. For a temperature of 2,000° K. the mean velocities are 3×10^7 cm./sec. for an electron and $1\cdot3 \times 10^5$ cm./sec. for an ion. The radius of gyration at the 600-km. level is 7 cm. for an electron and $1\cdot6 \times 10^3$ cm. for an ion.

It is to be noted that in the high atmosphere where collisions are few and far between, the lengths of the free paths, as first pointed out by Jones[7], are strongly dependent on their directions. In an upward direction this length may be many times that in a downward direction.

In conclusion, attention may be directed to the fact that, according to observations of Rayleigh and Spencer Jones[8], the seasonal variations of the intensity of night sky radiation are related to geomagnetic latitude. Since, as I have shown[9], the nocturnal Region F is to be identified with the luminescent layer of the night sky, the geomagnetic control of the intensity of night sky radiation can also be understood.

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Nuclear Magnetic Resonance and Spin Lattice Equilibrium

By measuring the absorption of radio-frequency energy by a substance in a magnetic field due to nuclear magnetic resonance[1,2], an estimate can be made of the order of magnitude of the time required for the establishment of thermal equilibrium between the spin system and the lattice. The absorption coefficient is proportional to the difference between the population of the magnetic energy states. The effect of the radio-frequency field is to tend to equalize the population of the states, so that in a strong radio-frequency field the absorption coefficient is less than in a weak field. This tendency to equalize the population of the states is opposed by the effect of the spin-lattice coupling, which tends to restore thermal equilibrium with the lattice. By finding the magnitude of radio-frequency field required to produce an appreciable reduction in the absorption coefficient, the relaxation time for transfer of energy from the spin system to the lattice can be calculated.

Measurements have been made by observing the damping of a resonant circuit due to the nuclear absorption by a method similar to that employed by Purcell, Torrey and Pound[2]. The specimen was placed inside the coil of a tuned circuit situated in a transverse magnetic field which was modulated at 750 c./sec. Radio-frequency power from a crystal oscillator was fed through the tuned circuit to an amplifier followed by a detector and tuned audio amplifier. When the mean value of the magnetic field was adjusted to a value near resonance, the radio-frequency power reaching the detector was modulated at 750 cycles by the variation in the loss in the tuned circuit due to the nuclear absorption. The signal to noise ratio was increased by the application of positive feedback to the tuned circuit. Measurements have been made at a frequency of 2 Mc./sec. and also at 16 Mc./sec The signal voltage due to absorption by protons in water at 16 Mc./sec. was of the order of a hundred times the noise voltage. An estimate can be made of the width of the resonance line by finding the change in signal amplitude with variation of the amplitude of modulation of the magnetic field.

Measurable absorptions have been observed so far only with substances containing protons or fluorine nuclei. Observations have been made at room temperatures and liquid air temperatures. In all the substances investigated, the results seem to indicate that the resonance line is stronger and sharper in the liquid than in the solid state; for example, with paraffin wax in the molten state, the width of the resonance appears to be about 2 kilocycles, but, on solidification, it increases to about 40 kilocycles, and the absorption coefficient drops correspondingly. From the change in absorption coefficient with input power, a relaxation time of the order of a second is derived for the liquid. In the solid state the relaxation time seems to be shorter. Most proton-containing liquids such as water, methyl and ethyl alcohol, acetone and benzene appear to have a relaxation time of about a second; but in glycerol it is shorter. Observations on ice have so far failed to indicate any measurable absorption, and it seems possible that this may be due to a greatly increased broadening of the line in the solid which makes the absorption coefficient too small to detect. A search has been made for absorption in heavy water, but so far no result has been obtained; the absorption coefficient is at least ten times smaller than in ordinary water. This may be due to a broadening of the resonance by interaction between the nuclear quadrupole electric moment and the internal electric field in the liquid. In fluorine compounds a strong sharp resonance has been found with a substituted liquid hydrocarbon (φ dimethyl cyclohexane, C_8F_{16}) and a weak broad resonance in calcium fluoride. A search for resonance absorption by other nuclei has so far given negative results.

Experiments have been made to find whether there is any change of relaxation time with temperature apart from the change on solidification. In the region between room temperature and liquid air temperature, there appears to be no considerable change.

Further measurements are in progress at liquid hydrogen and helium temperatures.

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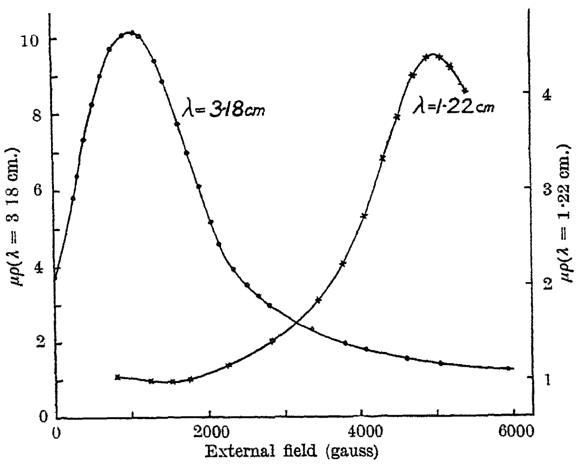
Anomalous High-frequency Resistance of Ferromagnetic Metals

THE energy lost by a high-frequency current flowing in a conductor is dependent on the product of the electrical resistivity ρ and the magnetic permeability μ of the conductor, and this fact has been used by several investigators[1,2,3] to determine the effective permeability of ferromagnetic metals at high frequencies.

In attempting to measure the permeability of ferromagnetic metals at wave-lengths of about 1–3 cm., it has been found that a new phenomenon appears. Normally when a magnetic field of greater than a few gauss is applied to a ferromagnetic metal, the differential permeability decreases steadily to 1 as the field is increased. At these high frequencies, however, it appears that there is a large increase in the product $\mu \times \rho$ at a certain magnetic field which depends on the frequency, as shown in the accompanying figure.



The experiment was performed as follows. A thin film (about 0·025 mm. thick) of the ferromagnetic metal was prepared by electroplating one side of a brass disk which formed one end of a cylindrical resonator, excited in the H_0 mode at a wave-length of 1 22 cm. A similar arrangement was used at 3·18 cm. except that the resonator was excited in the H_1 mode. A steady magnetic field H was applied with the lines of force parallel to the surface of the disk and the Q (circuit magnification) of the resonator measured for different values of the field H. From these measurements the change of the product μρ with magnetic field H may be determined. The values of μρ for nickel are plotted as ordinates in the figure against the magnetic field H. The 3 cm. curve shows, as expected, that as H increases to large values, μρ decreases to a constant value and the ordinate scale on the left of the figure, which refers to the 3-cm. measurement, gives the ratio of μρ to the value extrapolated to $H = \infty$.

The magnetic field available was not sufficient to enable an extrapolation of the 1 cm. curve to be made, and in this case, μρ at $H = 0$ is set equal to 1. This scale is shown on the right of the figure. Although it is difficult to determine the scale of the μρ values accurately, errors in this measurement will not change the shape of the curve, and the scales given in the figure are certainly of the right order of magnitude.

It will be seen that, superposed on the expected decrease of μ with magnetic field, there is a variation of $\mu\rho$, which has the appearance of a broad resonance curve, the value of H for which $\mu\rho$ is a maximum being dependent on the wave-length.

The results so far obtained are given in the accompanying table. No effect was found with silver-plated nickel.

Metal	λ (cm.)	H for $\mu\rho$ max. (gauss)	μ_H	H^1	$H\lambda \times 10^{-3}$	$H^1\lambda \times 10^{-3}$
Ni	1·22	5,000	2·3	7,150	6·1	8·7
,,	1·43	3,800	2·6	5,900	5·4	8·4
,,	3·18	1,030	7·3	3,180	3·3	10
Fe	1·22	2,800	8·6	9,900	3·4	12
,,	3·18	500	42	7,350	1·6	23
Co	3·18	510	26	4,760	1·6	15

Until more experimental work has been done, it would be premature to attempt a theoretical interpretation of these results, but the following points may be of interest. It is clear that the effect will depend on the magnetic field inside the metal which is acting on the magnetic dipoles. The demagnetizing field is fortunately negligible in the case of a thin film with magnetic field parallel to the surface, and a crude approximation to the internal field H^1 may be obtained by using the Lorentz expression

$$H + \frac{4}{3}\pi I = H\left(1 + \frac{\mu_H - 1}{3}\right),$$

where I is the intensity of the magnetization and μ_H the permeability at the field H. The values of H^1 are given in column 5 and of $H^1\lambda$ in column 7 of the table. A comparison of columns 6 and 7 shows that $H^1\lambda$ is less dependent on wave-length and material than $H\lambda$, but it increases with μ_H, particularly for large values of μ_H. The main uncertainty in this calculation lies in the use of the Lorentz field, which is unlikely to be correct when μ_H is large.

It is also of interest that the values of $H^1\lambda$ are of the order of magnitude of

$$\frac{2\pi \times mc}{e} = \frac{hc}{2\mu_B} = 10{\cdot}7 \times 10^3 \text{ gauss/cm.},$$

which is given by the relation $2\mu_B \times H = h\nu$, where μ_B is a Bohr magneton. This suggests that resonant absorption by the magnetic dipoles (which may, of course, be multiples of μ_B) is taking place, leading to a loss of energy from the field.

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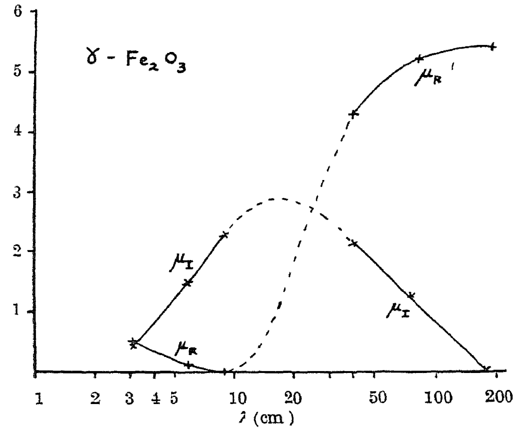
Magnetic Dispersion of Iron Oxides at Centimetre Wave-lengths

THE electromagnetic properties of ferroso-ferric oxide and gamma-ferric oxide have been measured at wave-lengths of 9, 6 and 3 cm. The oxides in powder form were mixed in various proportions with a low-loss, non-magnetic binder, paraffin wax. Moulded specimens of the mixtures were inserted in a slotted transmission line (coaxial line at 9 cm. and 6 cm.: H_{10} rectangular wave-guide at 3 cm.) fitted with a movable crystal detector probe, and measurements were made of the input impedances of the specimens when terminated in a short-circuit, and in an open-circuit (obtained experimentally by terminating in a short-circuited quarter wave-length line). The input impedance was derived from the voltage standing wave ratio n and the position of the voltage minimum. n was obtained indirectly from the relation $n^2 = 1 + \operatorname{cosec}^2 \beta x$, where β is the phase velocity in the measuring line, and x the distance between points at which the high-frequency voltage is $\sqrt{2}$ of its value at the minimum. In this way all measurements were carried out with crystal currents of less than 1·2 microamp., a range in which they were accurately proportional to the square of the high-frequency voltage.



The characteristic impedance z_0 (relative to that of the measuring line) and the propagation coefficient γ of a sample, thickness d, are obtained from the relative short-circuit and open-circuit impedances z_{sc}, z_{oc} by the relationships:

$$z_0 = \sqrt{z_{sc}\, z_{oc}}; \quad \tanh \gamma d = \sqrt{\frac{z_{sc}}{z_{oc}}}.$$

z_0 and γ are related to ε and μ, the complex permittivity and permeability of the material, by

$$z_0 = \sqrt{\mu/\varepsilon}, \quad \gamma = \frac{2\pi i}{\lambda}\sqrt{\mu\varepsilon}$$

for the coaxial transmission line, and by

$$z_0 = \mu\sqrt{\frac{1-(\lambda/\lambda_c)^2}{\varepsilon\mu - (\lambda/\lambda_c)^2}}; \quad \gamma = \frac{2\pi i}{\lambda}\sqrt{\varepsilon\mu - (\lambda/\lambda_c)^2}$$

in the case of the H_{10} wave-guide, where λ is the free-space wave-length, λ_c the cut-off wave-length of the guide.

From measurements on mixtures up to 50 per cent concentration, at the three wave-lengths, it is found that the complex permeability μ varies with v, the proportion by volume of the oxide, in accordance with the theoretical Clausius–Mosotti relation,

$$\frac{\mu - 1}{\mu + 2} = v\,\frac{\mu_a - 1}{\mu_a + 2},$$

where μ_a $(= |\mu_a| \exp(-i\mu'_a))$ is the complex permeability of the oxide (extrapolated to 100 per cent concentration). The derived magnetic properties of the two oxides are listed below.

	Fe_3O_4			γFe_2O_3		
λ in cm	8·93	5·97	3·085	8·93	5·97	3·085
$\lvert\mu_a\rvert$	2·53	1·72	1·08	2·30	1·49	0·65
μ'_a	66°	66·7°	63°	90°	86°	40·5°

In the figure, the real and imaginary components of μ_a for γFe_2O_3 are plotted, together with Hüttig's measurements[1] on the solid oxide for wave-lengths from 39 to 174 cm.

Both oxides show a rapid decrease of $|\mu|$ with wave-length, and this is accompanied by a large magnetic absorption. The similarity of behaviour of the two oxides is almost certainly due to similarity of crystal structure, as suggested by Welo and Baudisch[2] from their work with static magnetic fields.

The measurements are being extended to solid samples of the two oxides, and to other ferromagnetic compounds, and it is hoped to widen the wave-length range with measurements at $1\frac{1}{4}$ cm., 15–60 cm and in static fields.

I wish to acknowledge my tenure of an I.C.I. Research Fellowship, and also the loan of apparatus by the Telecommunications Research Establishment.

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[2] Welo and Baudisch, *Phil. Mag*, vi, 50, 399 (1925).

Reflectivity of Nickel

USING a special vacuum furnace and a new multiple-reflexion method to be described in detail elsewhere, I have determined the spectral reflectivity of nickel in the visible part of the spectrum over a range of 400° C. A beam of light from a 100-watt filament lamp was reflected four times at a nickel mirror, and compared with a standard beam from the same source, the intensity of the standard being reduced by means of a rotating sector until a match was obtained between the two for any given wave-length.

It was found that no discontinuity occurred at the Curie point. Following a theory of Gerlach's[1] and an investigation on the emissivity of nickel in the infra-red by Löwe[2], this was only to be expected: such a discontinuity does not occur for wave-lengths less than $4 \cdot 5\ \mu$.

The temperature coefficient of reflectivity was found to be positive and varied from $0 \cdot 85 \times 10^{-4}$ in the red to $1 \cdot 6 \times 10^{-4}$ in the blue. This is in good agreement with Reid's[3] value of $6 \cdot 6 \times 10^{-5}$ for $0 \cdot 8\ \mu$, and 0 at $2 \cdot 15\ \mu$. It is well known that in the infra-red the temperature coefficient of reflectivity is negative for all metals. In fact, for wave-lengths greater than $10\ \mu$, this coefficient is determined by the temperature coefficient of the electrical conductivity, the relation between reflectivity and conductivity σ being

$$R = 1 - 2\sqrt{\frac{\nu}{\sigma}}.$$

It is evident that for a certain wave-length the reflectivity coefficient must be zero. Attention was first directed to this phenomenon by Price[4], but no explanation was advanced.

It is also known that the above equation breaks down as the visible part of the spectrum is approached from the infra-red, and Mott and Jones[5] and Seitz[6] believe that a surface layer of very great resistivity is responsible. The above findings throw some light on this hypothesis. If a surface layer caused the reduction in reflectivity which is found, then it might also be expected that the absolute value of the temperature coefficient would be reduced, since work on thin films has shown repeatedly that, as the film under test is made thinner, its conductivity and the temperature coefficient of the latter are reduced. Yet this does not explain the appearance of a *positive* temperature coefficient. In a few isolated cases very thin films (other than bismuth) have shown a positive temperature coefficient of conductivity. These results have generally been dismissed as due to a faulty technique in the preparation of the films, etc. Such objections, however, cannot be raised in connexion with solid metal mirrors the thickness of which is 0·2 in In the case of reflectivity, two factors enter the picture . first the absorption coefficient ($n\,k$) and secondly, the dielectric constant (ε), where n is the ordinary refractive index, and k the extinction coefficient. Then, by Maxwell's equations

$$n\,k = \frac{\sigma}{\nu} \text{ and } n^2 - k^2 = \varepsilon,$$

ν being the frequency of light. The explanation advanced for the positive temperature coefficient of reflectivity is that, as the wave-length of light is reduced, the effect of the bound electrons becomes more marked, and thus the dielectric constant more prominent. To account for the positive temperature coefficient of reflectivity it is assumed that the part of the temperature coefficient of reflectivity to which the dielectric portions contribute is positive: this is a fair assumption since the dielectric constant of metals is often negative; if this constant is to have a meaning similar to that for insulators, its temperature coefficient also must be negative. Hence $\frac{-d(-\varepsilon)}{dT}$ is positive. Where the positive temperature coefficient of reflectivity (as conditioned by the dielectric) is equal to the negative coefficient (resulting from the free electrons or the conductivity), the point is obtained at which the temperature coefficient of reflectivity as determined by intensity measurements is zero.

To test the above hypothesis it is necessary to perform catoptric measurements so as to obtain the temperature variation of ε A new sensitive method has been devised to this end, and experiments are in progress further to elucidate this problem of reflexion.

The above investigation was carried out for the Pyrometry Sub-Committee of the British Iron and Steel Research Association, which has kindly given permission for this communication to be published.

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[6] Seitz, "Modern Theory of Solids" (McGraw-Hill Book Co.), Chap 17, p. 642

The Ethoxyfluorsilanes

Two compounds of this series, $(C_2H_5O)_2SiF_2$ and $(C_2H_5O)_3SiF$, were recently described by Peppard, Brown and Johnson[1]. I wish to point out that I had previously prepared and characterized[2] the three compounds $(C_2H_5O)SiF_3$, $(C_2H_5O)_2SiF_2$ and $(C_2H_5O)_3SiF$. The publication of this work has been prevented by war conditions; but a paper is now in preparation.

The monoethoxy compound is a colourless gas, boiling at about − 7°. It is unstable at room temperature, disproportionating rapidly into SiF_4 and $(C_2H_5O)_2SiF_2$. The disproportionation proceeds to about one third of completion, at which point an equilibrium is set up. However, the compound can easily be purified by high-vacuum distillation at low temperature and pressure. The solid melts at $-122°$. The diethoxy compound is also unstable by disproportionation; even when distilled in high vacuum at temperatures in the neighbourhood of $-30°$, it disproportionates about one eighth of the total into SiF_4 and one eighth into $(C_2H_5O)_3SiF$ at each distillation. Peppard, Brown and Johnson probably failed to note this compound as unstable, because of the circumstance that they distilled it only once with a long column; had they repeated the distillation, they would have observed the disproportionation. The triethoxy compound is the most stable of the three, having no tendency to disproportionate even at temperatures near its boiling point. The boiling point is 134 6°, by extrapolation from the vapour pressure curve. This agrees reasonably well with the American authors' figure of 133°–133·5°.

The monoethoxy compound was prepared by fluorinating $(C_2H_5O)SiCl_3$ with SbF_3, and the other two by fluorinating $(C_2H_5O)_3SiCl$ with SbF_3. Reaction is vigorous and no catalyst is needed. Disproportionation occurs during the fluorination (whence the possibility of preparing $(C_2H_5O)_2SiF_2$ from $(C_2H_5O)_3SiCl$), and a mixture of all three fluoro-compounds is formed when either of the chloro-compounds is fluorinated.

In attempting to prepare the three chloro-compounds by Friedel and Crafts' method, the mono- and tri-ethoxy compounds were easily obtained pure and stable to distillation, but the diethoxy compound disproportionated, and the whole fraction eventually resolved itself, on repeated distillation, into the mono- and tri-ethoxy derivatives.

This work was carried out at the Imperial College of Science and Technology, under the direction of Dr H. J. Emeléus.

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[1] *J. Amer. Chem. Soc.*, 68, 76 (1946)
[2] Ph D. Thesis, University of London, 1942

Bactericidal Power of Electrolytic Hypochlorite

IT has been long observed that hypochlorite liquor, freshly prepared by electrolysis of brine using carbon electrodes, possesses characteristic oxidizing properties distinct from chlorine water or from sodium hypochlorite prepared by the passage of chlorine into caustic soda solution. Masterman[1] made an extensive survey of the possible differences, and, using tetramethyl base, showed that electrolytic hypochlorite produced quite a different range of dyestuff colours from either of the other two chlorine agents. He suggested that this might be due to the presence of ozone in the electrolysed solution, since a similar colour reaction is given by that substance.

Experimental work carried out in this laboratory in 1938 on the oxidation of aniline confirmed Masterman's differential findings, but no evidence of the presence of ozone could be demonstrated.

Electrolytic hypochlorite is a buffered solution containing free hypochlorous acid and sodium hypochlorite. Degradation of hypochlorous acid produces hydrochloric acid which liberates further hypochlorous acid. It is possible that this labile hypochlorous acid is responsible for the enhanced oxidizing powers. It is significant that commercial hypochlorite is stabilized by alkalinization to pH 10, whereby free hypochlorous acid is neutralized.

Chlorine water, on the other hand, is still a solution of the gas (since the bulk of it may be removed by aspiration), and its oxidizing action probably occurs after chlorination of the reducing agent. A further suggestion that the electrolytic solution contains amounts of chlorites should also be borne in mind

That there is a marked difference in the oxidation potential of the three substances may readily be demonstrated by their behaviour as bactericides to certain organisms.

In an experiment a large quantity of water was divided into four equal volumes in sterile containers, and to each was added a similar measured quantity of suspension of *B. coli* in water medium. These were then treated respectively with 2 p.p.m. 'available chlorine', of chlorine water, sodium hypochlorite solution (commercial) and electrolytic brine solution. The fourth acted as control. After given time intervals, samples were taken from each and the oxidizing agent 'killed' by addition of sodium thiosulphate solution. Equal quantities of the samples were then plated out on lactose-agar medium and incubation carried out. In the accompanying table the figures represent indices of colonies of *B. coli* produced after 72 hours incubation.

Contact time	Commercial hypochlorite	Chlorine water	Electrolytic hypochlorite	Control
0 min.	10	10	10	10
3 "	7	7	7	10
6 "	5	5	2	10
15 "	3	4	0 5	10
30 "	1	2	nil	10

It will be seen that, for equal quantities of oxidizing agent as measured by arsenite-iodine titration, electrolytic hypochlorite has definitely a more rapid bactericidal effect. These tests have been carried out with a number of different organisms using varying concentrations, with or without ammonia being present. In every case it is observed that the electrolytic hypochlorite has a more rapid bactericidal effect.

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[1] Masterman, A T., *Analyst*, 64, 492 (1939).

Physiology in Horse-racing

DEEMING the scientific world interested in all things, and competent to contribute useful help, I make no apology for introducing the subject of horse-racing and the riding of races therein.

Horse-racing is not a particular hobby of mine, but I have been much struck on a visit to Ascot races by the fact that, whereas in sprints up to a mile all jockeys try to keep among the prominent horses throughout the race, relying on extra speed at the end to win, in long-distance races there seems to be almost competition to be last at the beginning in order to be first at the finish. I cannot believe that this is based on the Biblical adage, but that in the minds of the very shrewd people whose business it is to do these things, it is thought to show advantages.

Now there are one or two fundamental considerations that seem to be forgotten, and one is that whoever covers the distance in the shortest time will win, though they may finish at a pace slower than any other horse running. Surely, therefore, a horse, like anything else having a limited amount of energy to expend, should go fast downhill and ease himself uphill. This apparently simple expedient is taboo I notice, anyhow at Ascot, where horses are pulled violently to prevent undue speed on the downhill, but must go fast uphill towards the finish.

I acknowledge the advantage of being paced from an aeronautical point of view, but provided you are not first, not much advantage accrues from being last as compared with second. There is also the fact that on any form of circuit, whatever its size, if you run parallel to another horse and can at no time get on the rails, you will have to go (allowing 4-ft. separation) 26 ft. farther. To be on the rails, therefore, is a definite advantage.

A race between a great French horse and a great English horse which I witnessed at Ascot will illustrate my point. The distance was two and a half miles. The French horse was instantly put among the leaders, using the downhill to get there easily, and lay third for most of the race. The English horse was pulled back at the beginning so as to be last, and for most of the race was at least 100 yards behind the Frenchman. Not until about seven furlongs from home, when the going was uphill, was he asked to close the gap. Nobly he did it, but when abreast of the Frenchman, the Frenchman was able easily to shoot ahead and win.

These tactics struck me as scientifically unsound. Were the tactics reversed a different result might have occurred, for I contend, and here I want corroboration or rebuttal, that the English horse was asked to exert more energy in that race than the Frenchman.

Dynamically and physiologically there is mechanical error here, that shows itself in tactics, that has crept into racing and wants exposing, and I should indeed like the views thereon of readers of *Nature*.

Tod Sloane with his forward seat revolutionized riding by jockeys, and he was scientifically right. It would indeed be very enjoyable if *Nature* could expose other fallacies in at present accepted turf procedure.

Brabazon of Tara

70 Pall Mall,
London, S.W.1.
Oct. 17.

I know nothing about the technique of horse-racing, and there may be subtle reasons, or prosaic ones such as not desiring to break the horses' legs, why jockeys should not let their horses go too fast downhill. If, however, they were human and not equine runners, I should certainly say go faster downhill and slower uphill; at a guess, but I have not tried to work it out, I should say let them exert total energy at the same rate throughout the race. They would require less energy to run at the same rate downhill and more energy to run at the same rate uphill; so at a constant rate of energy expenditure they should go faster downhill and slower up.

For running on the flat the results of all physiological experiments allowed one to predict (and I did so predict a good many years ago) that the best times would be done by running at a uniform speed throughout a race. The energy spent in running a given distance increases as some power of the speed, so that you gain less during the time you go slow than you lose during the time you go fast. Running downhill is exactly like running with a following wind: the hill provides some of the energy to overcome air-resistance, the following wind reduces the air resistance. If I were advising human runners on a circular track on a windy day I should say run fast when the wind is behind and slow when the wind is ahead.

I wrote a paper on "The Air Resistance to a Runner"[1]; Best and Partridge wrote one on "The Equation of Motion of a Runner Exerting a Maximum Effort"[2]. Both these papers have a bearing on the same problem. Another paper on the same topic is that by Sargent on "The Relation between Oxygen Requirement and Speed in Running"[3].

Winning races is not always the same thing as doing the best time: there is tactics as well as strategy about it. Certainly, however, for doing the best time and getting the utmost out of oneself over a given distance, these rules apply. I see no reason why they should not apply to horses as well as men. Perhaps Lord Brabazon would like to repeat on horses (if the R.S.P.C.A. would let him) the experiments which Best, Partridge, Sargent and I made on men!

A. V. Hill

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Oct. 21.

[1] *Proc. Roy. Soc.*, B, **102**, 380 (1928).
[2] *Proc Roy. Soc.*, B, **103**, 218 (1928)
[3] *Proc. Roy Soc.*, B, **100**, 10 (1926).

Soil Perfusion Apparatus

In view of Audus's communication[1], which describes a modification of my original design of perfusion pump, it is perhaps relevant to note that I simplified the apparatus myself more than two years ago. The simplified apparatus was, as Audus's, actuated by unidirectional air flow and was used for months in experiments that demanded a control of composition of the inflowing gas. It also incorporated the idea of using air-flow through a capillary to regulate an air-pressure difference. This modified design is described in an addendum to some forthcoming papers by Dr. Quastel and myself[2].

Those who contemplate using the perfusion technique may, however, be interested to learn that an entirely new design, far simpler than either Audus's modification or my own, has now been reached. It has been in constant use in this laboratory for eight months; it is completely self-regulating, is worked by unidirectional air (or gas) flow and represents what I believe to be the limit of simplicity in apparatus of this sort. The apparatus[3] was demonstrated at a meeting in Manchester of the Society of Public Analysts on October 19. The design has much to recommend it to bacteriologists, in that a small-scale version of it can be sterilized complete in an autoclave.

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[1] *Nature*, **158**, 419 (1946).
[2] *Biochem. J.*, in the press.
[3] *J. Agric. Sci.*, in the press.

A MICROCHROMATOGRAPHIC METHOD FOR THE DETECTION AND APPROXIMATE DETERMINATION OF THE DIFFERENT PENICILLINS IN A MIXTURE

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MARTIN and co-workers[1] extended their technique of partition chromatography of the amino-acids to the micro-scale by using filter paper instead of silica gel as the support for the stationary phase (water). We have found that the modified partition chromatogram for penicillin using buffer as the stationary phase[2] can also be adapted to the micro-scale by the same change in support. Colour reactions are not readily applicable to locate the positions of the invisible developed zones, so that a micro-biological procedure has been used both to identify and to determine approximately the types and amounts of penicillins resolved on the buffered paper strip. The procedure is as follows.

Filter paper (Whatman No. 1 or 4) is soaked in approximately 30 per cent potassium phosphate buffer of *p*H 6–7 according to requirements (the *p*H is measured on the solution after dilution to 1 per cent). Excess buffer is removed by pressing between sheets of blotting paper, and the impregnated paper is allowed to dry in air. It is then cut into strips 1·8 cm. by 33 cm. Uniform width is essential. The strips are kept in a damp atmosphere for one hour immediately before use.

The sample in the form of a salt is dissolved in phosphate buffer (similar to that applied to the paper) to form a solution containing 1,000–30,000 units per ml. (by *B. subtilis* assay). Insoluble phosphates are removed. Alternatively, similar concentrations of the free penicillins in solvent solution can be used, but only the qualitative aspect of this modification has been explored.

A 1-microlitre spot of the test solution is placed centrally near one end of each of the test strips, which in sets of six replicates are then submitted to chromatographic development in a gas-tight apparatus as described in ref. 1. It is preferable to have a separate reservoir for supplying solvent to each strip. Arrangements are made to provide an atmosphere of water vapour and solvent in the apparatus, and the strips are exposed to this atmosphere for about two hours before development is commenced. The apparatus must be kept at 0–5° C. throughout the experiment.

The extent of development obtained is related to the type and throughput of solvent, which is normally 10 ml. of water-saturated ether per strip. Other water-immiscible solvents can also be used. After 20–24 hr., when the reservoirs are exhausted of solvent, the disposition and approximate amount of each invisible penicillin zone is determined by the following biological technique.

Uniform sheets of medium (about 2 mm. thick and 35 cm. square) are prepared by pouring molten agar at 70° C. pre-inoculated with *B. subtilis* (as in the cup-assay for penicillin) into sterile plate glass trays. After each agar sheet has been cooled to approximately 5° C. the six replicate test strips and one strip carrying a set of undeveloped standard spots of graded concentration (see below) are pressed on the surface of the agar at equal intervals. The standard spots are prepared by delivering, at 5 cm. intervals down a buffered strip, a set of six 1-microlitre spots pipetted from a set of serial dilutions of sodium penicillin II in buffer solution (for example, 30, 10, 3·3, 1·1, 0·37 and 0·12 units per microlitre). After allowing the 'penicillin activity' to diffuse out from the paper into the agar during 3–4 hr. at 0–5° C. the plates are incubated at 37–38° C. overnight.

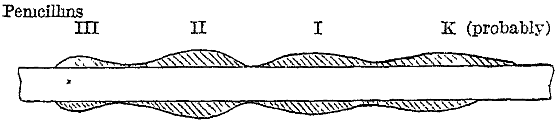

Fig 1

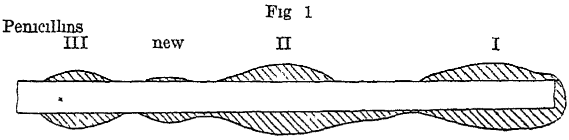

Fig 2

×, POINT AT WHICH PENICILLIN SOLUTION WAS APPLIED ; AREA OF INHIBITED GROWTH IS SHADED

The standard spots, which have not been chromatographically developed, give a series of circular inhibition zones, whereas each developed test strip shows a number of elliptical zones (as in Fig. 1) indicating the distance which each resolved penicillin zone has travelled down the paper.

The identity of the zones for penicillins I, II and III was established by comparison with the results obtained from artificial mixtures of these penicillins. The results were closely parallel to those obtained on macro-columns.

It was established in accordance with chromatographic theory that the ratio of the distances travelled on a given strip by a given pair of penicillins was constant regardless of the total degree of development. The position of the penicillin II zone can be easily established. Hence, using the position of this zone as a basis for comparison, this ratio was determined for other zones, and the figure was regarded as a convenient characteristic for identification. Only penicillins I, II and III are available for direct comparison. At least four other zones of activity have been observed and characterized by this ratio. Whether they are identical or not with penicillins reported by other workers on macro-columns can at present only be inferred.

A typical analysis is shown in Fig. 1.

Quantitative. Sets of serial dilutions of sodium penicillin-II were repeatedly compared after development on the chromatographic strips with the same solutions as undeveloped standards. For the developed zones it was found that maximum width of zone is equal to $a' + b'$ log (units in zone), where a' and b' are constants for a particular biological plate.

For the undeveloped solutions a similar relation holds, namely, diameter of zone equal to $a + b$ log (units in zone), as in the ordinary cup assay.

For the same biological plate, b' was found empirically to be about 1·2 times b, but no means of relating a to a' was found. Hence the activity of the developed zones in absolute *B. subtilis* units could not be determined. To evaluate relative proportions, b was calculated from the undeveloped standards and multiplied by 1·2 to give an estimate of b'. If it is now assumed that $a' = 0$ the expression

$$\log\,(\text{units in zone}) = \frac{\text{maximum width}}{b'}$$

gives values for the activities of the zones in units which are arbitrary, but proportional to *B. subtilis* units. The percentage composition in these units is then calculated.

The standard error of these proportions for one sample replicated on six strips is of the order of $\pm$ 15 per cent. Even less than 0·1 per cent of any penicillin in a mixture can readily be detected, but the accuracy of estimation at the lower values is rather less.

From the activity per unit weight of the pure individual penicillins against *B. subtilis*[3], the proportions of the penicillins by weight is readily calculated.

Similarly the ratio $\frac{\text{units against } B.\ subtilis}{\text{units against } S.\ aureus}$ for the whole sample can be calculated, and compared with the value obtained by direct assay. The following are some pairs of results obtained with samples from different sources.

	Values of units against *B. subtilis* / units against *S aureus*		
Calc from results of micro-chromatographic analysis	0 69	0 71	0 98
Direct assay	0 65	0 71	0 983

The method has proved of value in a number of directions; for example, for establishing whether a purified penicillin is free from traces of other penicillins; or as a guide when carrying out macro-chromatograms, etc. The delicacy of the test is well illustrated by the discovery of a small amount of what is almost certainly a new penicillin in samples of varying origin. This penicillin was detected in the sample shown in Fig. 1, when chromatographic development was made at a lower *p*H. As a result (Fig. 2), the two upper zones became further separated, revealing a small zone due to the new penicillin.

A full report will be published shortly.

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[2] Levi, A A, and Terjesen, S G, Brit. Pat. 569844.
[3] Schmidt, W. H., Ward, G. E., and Coghill, R. D., *J. Bact*, **49**, 411 (1945).

ACTION OF PENICILLIN IN PREVENTING THE ASSIMILATION OF GLUTAMIC ACID BY *STAPHYLOCOCCUS AUREUS*

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CERTAIN bacteria possess the ability to assimilate glutamic acid and to concentrate this amino-acid in the free state within the internal environment[1]. Glutamic acid cannot pass through the bacterial cell-wall by free diffusion as the migration requires energy which can be supplied by exergonic metabolism such as the fermentation of glucose by the organism. At equilibrium the concentration of glutamic acid in the internal environment is markedly greater than that holding in the external environment. Since a survey of a large number of bacterial species has shown that this capacity to assimilate and concentrate glutamic acid is restricted to Gram-positive organisms[2], it was decided to investigate the action on the assimilatory process of various chemotherapeutic agents which are known to differentiate between Gram-positive and Gram-negative bacteria.

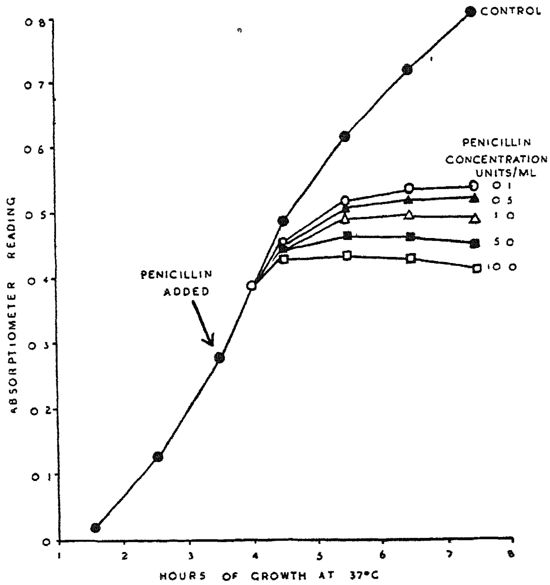

Fig. 1. EFFECT OF ADDITION OF PENICILLIN TO GROWING CULTURES OF *Staphylococcus aureus*.
Medium: salt mixture + 0 1% 'Marmite' + 1 0% glucose. Penicillin concentrations in Oxford units per ml. medium

Penicillin is primarily effective against Gram-positive bacteria. Chain and Duthie[3] found that whereas penicillin has no effect on the respiration of resting cells, its addition to growing cultures of *Staph. aureus* gives rise to an inhibition of respiration which progressively increases until eventually the oxygen-uptake ceases altogether. The addition of penicillin during the lag or the logarithmic phases of growth is followed by a period during which the cells increase in size without undergoing normal division —not more than one division taking place before growth ceases—after which both total and viable count of the cells decrease with time and general lysis takes place after some hours[3]. Hirsch[4] obtained similar results and showed that, after the addition of penicillin to growing cultures of *Staph. aureus*, the oxygen consumption of the culture increases normally for a time and then, after a stationary period, decreases. He suggested that the action of penicillin is to produce a degenerative change which results in the production of a sterile generation of cells. Both sets of workers showed that the same effects are produced by a wide range of penicillin concentrations.

Fig. 1 shows the effect of the addition of various concentrations of penicillin to growing cultures of *Staph. aureus*; the ordinates give the readings of the absorptiometer scale by which the increase of turbidity consequent upon cell-growth is measured. Within the range of concentrations tested (0·1–10·0 Oxford units/ml.) the addition of penicillin to the growing culture is followed by increasing turbidity for 1–2 hr. Viable counts show that approximately one division per cell occurs during the period immediately following the addition of penicillin, after which there is a steady loss of viability over a period of several hours.

The strain of *Staph. aureus* used for this work is one which effects a high concentration of glutamic acid in the internal environment, and studies were first made on the internal environment of the cells

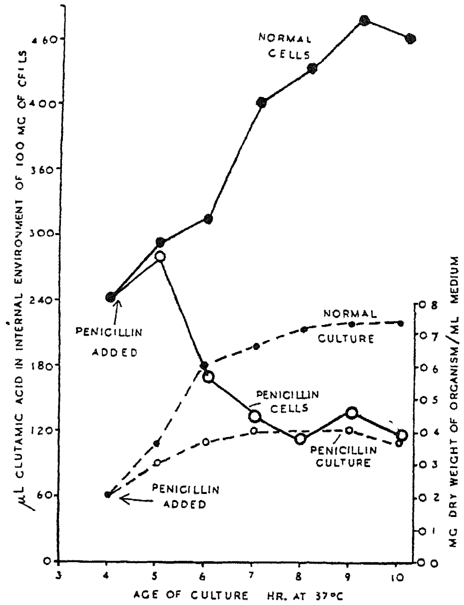

Fig. 2. EFFECT OF ADDITION OF PENICILLIN TO GROWING CULTURES OF *Staphylococcus aureus* ON THE ACCUMULATION OF FREE GLUTAMIC ACID IN THE INTERNAL ENVIRONMENT OF THE CELLS

Full line, internal concentration of glutamic acid; broken line, turbidity of culture as indication of growth

during normal growth and during growth after the addition of five units penicillin per ml. medium (Fig. 2). The medium used for these investigations consisted of casein-digest containing 1 per cent glucose and 0·1 per cent 'Marmite' and was consequently rich in glutamic acid. During normal growth in this medium the internal concentration of free glutamic acid rises steadily throughout the growth period as previously reported for streptococci[1]. After the addition of penicillin to the growing culture, the internal concentration of glutamic acid rises normally for the first hour, after which it falls rapidly and reaches a steady level at approximately the same time as the turbidity ceases to increase. The curves of these changes (Fig. 2) suggest that assimilation of glutamic acid by the cells ceases shortly after the addition of penicillin.

Since the concentration of glutamic acid attained inside the cell is dependent upon, though much higher than, the external concentration, it is possible to study the assimilation if cells are grown in a medium containing minimal glutamic acid and are then incubated in buffer solution containing both glucose and a high concentration of glutamic acid[1]. A suitably 'deficient' medium for the growth of *Staph. aureus* consists of nutrient salt solution containing 0·1 per cent 'Marmite' and 1·0 per cent glucose. The effect of penicillin on glutamic acid assimilation has been studied by growing the organism in this medium and adding penicillin to the growing culture (Fig. 1). At intervals after the addition of penicillin, the organism has been harvested on the centrifuge, its internal glutamic acid content assayed and the suspension then incubated at 37° C. in a suitable salt solution containing 0·5 per cent glucose and 200 μl. glutamic acid per ml. After 1 hr. (when equilibrium has been reached) the cells were centrifuged down, washed once in water, and the internal glutamic acid content again determined. The increase in the internal concentration can then be taken as a measure of the glutamic acid assimilated under these conditions. Table 1 shows the amount of glutamic acid assimilated by 100 mgm. dry weight of cells harvested under various cultural conditions.

Cells from the normal (penicillin-free) culture take up 560–700 μl. glutamic acid per 100 mgm. under the conditions of test, and this assimilation is unaffected by penicillin up to 200 units per ml. Cells taken from cultures to which penicillin has been added during growth show impaired assimilatory power. Within 30 min. of the addition of 10 units penicillin per ml. to the culture, the assimilation has fallen to 14 per cent of that of the control culture; within 1 hr. the assimilation has fallen to 4 per cent of the control, and after 90 min. assimilation is no longer possible. Smaller concentrations of penicillin have the same effect but take longer to prevent assimilation completely. If the assimilation values given in Table 1 for cells harvested 90–120 min. after the addition of penicillin are compared with the 'growth' curves in Fig. 1 or with the increases in turbidity during the time of harvesting, it can be seen that there is a correlation between impairment of assimilation and cessation of growth.

TABLE 1 EFFECT OF THE PRESENCE OF PENICILLIN DURING GROWTH ON THE ASSIMILATION OF GLUTAMIC ACID BY *Staphylococcus aureus*

Penicillin concentration (Oxford units per ml. medium)	μl. Glutamic acid assimilated/100 mgm. cells — Time of harvesting after penicillin addition: 30 min.	1 hr	1½ hr	2 hr.	3 hr.	Increase in turbidity during 1–2 hr. after penicillin addition as % control
0	561*	702	602*	590	614	100
0·1	—	—	—	130	—	54
0·5	—	—	—	113	—	37
1·0	—	—	87	—	nil	22
5·0	—	—	nil	nil	nil	7
10·0	82	31	nil	nil	nil	0

* Also determined in presence 50 units penicillin/ml —no effect

TABLE 2 METABOLIC ACTIVITIES OF NORMAL AND 'PENICILLIN-CELLS' 'Penicillin-cells' grown for 90 min. in medium containing 10 units penicillin per ml

	Normal cells	Penicillin-cells
Respiration, Q_{O_2}	21·5*	19·6*
Glucose oxidation, Q_{O_2}	86·5*	84·5*
Glucose fermentation, $Q^{acid}_{CO_2}$	96*	108*
Lysine assimilation (μl./100 mgm.)	90	96
Glutamic assimilation (μl./100 mgm.)	602	nil
Comparative viable count	452	9

* Also determined in presence 50 units penicillin/ml —no effect

The loss of assimilatory power by the cells grown in the presence of penicillin is not affected by washing the cells in water and is not restored by treatment with cysteine. The assimilation of glutamine is impaired to the same extent as that of glutamic acid. Table 2 shows the general metabolic activities of normal cells compared with those of cells harvested from a culture grown for 90 min. in the presence of 10 units penicillin per ml. medium (cells referred to as 'penicillin-cells'). Rates of respiration, oxidation and fermentation of glucose were determined in the usual manner in Warburg manometers using washed suspensions. There is no significant difference between these activities in the two cultures, and the addition of penicillin to the washed suspensions has no effect in any of these tests.

The assimilation of lysine by Gram-positive bacteria appears to be due to diffusion of the charged ion in an electrical field and not to a mechanism such as that involved in glutamic acid assimilation[1]; Table 2 shows that the assimilation of lysine by normal and 'penicillin-cells' is the same, demonstrating that the cell-wall is intact in both cases. No lytic action of the type shown for the action of tyrocidin and detergent substances[5] has been found for penicillin, although lysis of the cultures containing penicillin takes place after several hours[3]. Penicillin is known, so far, to have four effects on *Staph. aureus*. (1) the cells become non-viable[3]; (2) their respiration progressively fails[3,4]; (3) lysis occurs after several hours; and (4) assimilation of glutamic acid is prevented. The results shown in Table 2 indicate that the prevention of assimilation precedes both respiratory failure and lysis of the cells, and would appear to take place simultaneously with loss of viability.

The mechanism whereby glutamic acid is assimilated and concentrated within the internal environment of the Gram-positive cell is not yet understood. Since penicillin has no effect upon this mechanism in normal cells but affects cells during growth in such a way that assimilation is prevented, this suggests that penicillin either combines with or produces a reorganisation of the cell-wall such that the assimilatory mechanism is blocked. In these experiments the cells contain a high concentration of glutamic acid at the time of the addition of penicillin, and it has been shown that the further metabolism of this glutamic acid is the same whether penicillin is added or not. In the normal cell this metabolism is balanced by further assimilation; but in 'penicillin-cells' assimilation is prevented, and consequently the internal concentration of glutamic acid decreases as shown in Fig 2.

Full details of this work will be published later.

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[2] Taylor, E S, *J Gen. Microbiol*, 1 (in the press, 1947).
[3] Chain, E, and Duthie, E S. *Lancet*, **248**, 652 (1945)
[4] Hirsch, J, *C.R Ann. Arch Soc Turque Sci Phys Nat.*, Fasc. 12 (1943–44)
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CHICAGO NATURAL HISTORY MUSEUM

ANNUAL REPORT

THE report for 1945 of the Chicago Natural History Museum, produced in magazine form and well illustrated, is an attractive publication which at once invites attention. Its perusal gives one, in the first place, the impression that here is an institution which is strongly 'public conscious'. In the second place, one is convinced that the Chicago Museum is happily succeeding in a great public service and that Chicago citizens, as a result, are 'museum conscious'. The large number of volunteer workers (who have rendered valuable service both inside and outside the Museum), the large museum membership, and the long lists of donors and other benefactors shown in the report substantiates that conclusion. Further, if the status of a museum within a community can be judged from the financial support it receives, then that of the Chicago Museum stands high. Ideas as to the manner of the financial support proper to museums may differ, but however debatable that point may be, it is of considerable interest that the very active educational and research work taking place in this Museum is made possible by endowments and voluntary public subscriptions alone. In 1945 the Museum's income amounted to 601,796.85 dollars (of which 348,336.53 dollars accrued from endowment funds). In addition, there was the income of 16,609.88 dollars from the N.W. Harris Public School Extension endowment. Expenditure out of these sums amounted to 596,471.89 dollars and 16,727.49 dollars respectively.

In Britain the large majority of museums (excluding the great national institutions) are usually maintained by local rates, and although in most, if not all, cases they are entirely free to the public, comparatively few have a permanently active or important part in the cultural and educational life of the people. The cause does not require much seeking in view of the general inadequacy of the funds allotted them—a deficiency which, except in rare cases, gives rise to administrative inefficiency and precludes that vigour of policy so apparent in many American museums

The Chicago Natural History Museum, judging from the report under discussion, shows this vigour in policy in a number of directions. For example, with the cessation of hostilities, plans for the resumption in 1946 of archæological, botanical, palæontological and zoological field explorations on a large scale were drawn up, and in this connexion the report states: "The continued expansion of the Museum in exhibits, in study collections and in scientific research is mainly dependent upon such a programme". Again, in co-operation with the University of Chicago and the Northwestern University, a scheme (already in part operation) has been drawn up which will facilitate the greater use of the Museum's collections and the teaching of natural science by the Universities. Towards this, certain reciprocal staff appointments have been made, and there are plans for the further co-ordination of the work of the three institutions in fields of mutual interest. Another interesting connexion with the University of Chicago is the establishment of university classes in museology in the Department of Anthropology of the Museum

Among the various other schemes carried out by this Museum during 1945 the following are noteworthy: a special series of radio broadcasts within the Museum conducted by means of portable equipment set up in the exhibition halls; lectures, tours and motion picture shows for school children; the presentation of a series of weekly radio broadcasts on "Places and People" in conjunction with the Radio Council of the Chicago Public Schools; and the production of reading matter for children in the form of the "Museum Stories" published weekly, the spring series dealing with brief sketches of young animals, and the autumn series with the Indians of the Chicago region. Under the N. W. Harris Public School Extension Scheme, 498 Chicago schools continued to receive on loan from the Museum portable exhibits, and it is noted that the more than 1,100 available exhibits are in constant use during the ten months of the school year.

Under the heading of "Public Relations", the report describes such special events as temporary exhibitions on a variety of subjects of general interest; the stage presentation of the temple dancers of Bali and Java, and evening lectures on "timely topics". These formed the basis of the Museum's press and radio publicity for the year, and, together with many of its other activities, received "lavish attention" in the Press—some papers publishing half to full pages of pictures. It is interesting to note in this connexion that the *Illustrated London News* has published several pages of some of the Chicago Museum's exhibits. Further useful publicity was given this Museum when the Chicago radion station broadcast a unique feature programme presenting the work of the Museum 'behind-the-scenes'.

In this review, which has been written primarily to show how highly valuable museum services can be under keen administration and modern methods of presentation, it is not possible to note with adequacy the vast amount of work (research and otherwise) which was carried out by individual Departments of the Museum during the year. This section of the report, however, cannot be passed over without reference to a special exhibit prepared in the Department of Geology. This illustrated the production of uranium, and it was arranged with a map of the world bearing the sub-title, "Sources of Energy for the Atomic Bomb". "The map," to quote the report, "brings out the fact that the United States and Canada are favoured among the nations in their possession of major deposits of Uranium ore, but emphasises that they by no means enjoy a monopoly of it. In fact, the rather general distribution of the ore stresses the ultimatum that Science has presented to the peoples of the world: 'Unite or perish'."

Attention must be directed to the photographic production that takes place in the Chicago Natural History Museum: during 1945 there was an output of 19,792 items. These included negatives, prints, enlargements, lantern slides, transparencies and colour films, and were made for the various Museum departments, outside institutions, the Press, book publishers, and for sale to the public.

Compared with the American museum movement, that of Great Britain has still far to travel. The time for large-scale reorganisation and the introduction of new ideas and new methods is long overdue. The slight movement that was being made in this direction before the War was brought to a standstill when hostilities broke out in 1939, and now 1947 is on the horizon. During these seven years many British museums (those which escaped destruction and those that were partly destroyed) have made a valiant effort to overcome their difficulties and to render useful service. These museums are now slowly struggling back to their pre-war aspect. Collections are returning, or have returned, to buildings which before the War were already overcrowded and often unsuitable for the execution of museum services in keeping with modern needs and modern developments. Some museum authorities, looking to the future, have schemes in plan for reconstruction or new buildings, but it does not appear likely that museum accommodation will be built in Britain in the near future. A further factor which stems progressive action is the non-recognition of the educational potentialities of museums in those official quarters which would otherwise be the most helpful. Furthermore, governing authorities themselves far too frequently see nothing more in the museums under their control than repositories for municipal and collectors' treasures. Any extra expenditure on these, therefore, is considered unnecessary. Nevertheless, the claim of the British museums is a strong one, for collectively they house a great wealth of material which, in relation to the education and cultivation of the ordinary people, has, as yet, scarcely been tapped. The improvements looked for, however, may not come without some form of outside impetus—a vigorous central body to press their claims and with powers to prevent the opening of new museums if funds sufficient for their efficient maintenance are not in sight; a greater and more practical interest in their functioning on the part of the national institutions, and the recognition of all other educational institutions, are what British museums need at the present time.

NUTRITIONAL INVESTIGATIONS IN MAURITIUS

It is encouraging to find that even the smaller territories are now taking an interest in nutrition, but they will have to do better work and produce better reports than that surveying investigations in Mauritius during 1942–45, which has recently been issued*.

At first reading, one supposes it is merely a case of careless checking; for example, in Fig. 1 all nutrients and also calories are said to be given in terms of grams (actually they are expressed in a most odd variety of units, calcium being in centigrams and thiamin and riboflavin in hundredths of a milligram); in Appendix 2 the values for "vitamin B_2" are said to be in I.U. (the figures appear to be for riboflavin expressed in milligrams), and no indication at all is given of the units used for nicotinic acid and ascorbic acid. There are also major differences between values given in the appendix and those in other parts of the report, and the general atmosphere of confusion is added to by strange phrases such as, "This is, of course, expectable" and "not to any consequential degree".

On closer examination, however, it is evident that the faults go much deeper. The introduction and the discussion on pages 28–30 of the report deal with the total food supplies available (based on imports, exports and local production), and an attempt is made to relate them to the requirements of the population. The only satisfactory way of doing this is on a 'per head' basis (the method adopted by the United Nations Food and Agriculture Organisation); but the author has preferred to use the long-discredited 'man-value coefficients' based on calories alone. For the requirements of his standard 'man' he uses the original (since modified) *nutrient* recommendations of the U.S. National Research Council for a moderately active male living in a temperate climate and eating an American type of dietary, but he supplies a *calorie* recommendation of his own. He shows no appreciation of the factors which determine requirements or of the interrelationship between different nutrients and between some nutrients and calories.

Table 1 compares "per man-value" daily intakes in different years, and shows considerable fluctuations which are duly 'explained' in the text. But these fluctuations are much greater than can be accounted for by changes in the supply position as detailed in Appendix 1. Only one set of figures relating to the intermediate step (amount of each *food* per man-value) is given, and this tallies neither with the amounts of foods given in Appendix 1 nor with the amounts of nutrients given in Table 1. Either the figures in the appendixes were not, in fact, used for the calculations (though it is stated that they were), or there have been errors in arithmetic; whichever way it may be, it makes it difficult to know how much

* Colony of Mauritius. Final Report on Nutritional Investigations in Mauritius, 1942–45. Pp iv+89. (Port Louis Gov. Printer; London: Crown Agents for the Colonies, 1946.) 1 Re.

value to set on the report at all, since the greater part of it is based on these evaluations.

Another part of the report deals with the influence of feeding on malarial infection and the experimental feeding of school-children. The first describes the feeding of dietary supplements to children suffering from malaria, but here again arithmetical anomalies make it impossible to judge the value of the work, since the figures given under the heading "nutrients supplied" are not in agreement with the analytical values given in the text for the foodstuffs used, and show discrepancies even in the comparison of one supplement with another.

The experimental feeding of school-children is not described in sufficient detail for any assessment of its significance; but it appears certain that it was carried out without adequate supervision, since it is stated that "owing to the large variation in amounts given per child in the different schools it was impossible to record actual nutrients supplied". It is suggested, however, that each meal should have supplied about 200–300 calories. As the main item was soup, it is very probable that even this calorie value may not have been reached on all occasions, and (as is recognized) school meals are often a substitute rather than a supplement. In view of this and the fact that the experiment only lasted three months, the failure to obtain spectacular proof of the great value of school meals is not so "extraordinary" as the author thinks. No observations seem to have been made on any changes other than weight, or of the initial nutritional state of test and control groups. Those wishing to embark on school-feeding "experiments" would save themselves (and others) a lot of trouble if they would study Cory Mann's report before they begin.

Other sections deal with laboratory investigations (chiefly analyses of local foodstuffs), and with recommendations for the preparation and use of autolysed yeast and of green Algæ. Here also there are examples of arithmetical discrepancies and arguments based on false premises.

Clearly this report should have been submitted to more critical consideration prior to publication. If recommendations are to be made, and possibly action taken, on such foundations, the end result may be a worse state of malnutrition than at present exists.

M. W. GRANT

NORTHERN POLYTECHNIC JUBILEE (1896–1946)

THE Northern Polytechnic, London, was opened on October 5, 1896, following the approval given by Queen Victoria on August 5, 1892, to the scheme of foundation. It celebrated its jubilee by an exhibition of students' work on October 24 and 25, and by a luncheon attended by the Minister of Education, the Rt. Hon. Ellen Wilkinson, M.P.

Miss Wilkinson, speaking of the Polytechnic, directed attention to the fact that the chairman of the governors, Mr. R. L. Roberts, and his father had been associated with the foundation and development of the Polytechnic since 1892, and that a member of the third generation had, at the last meeting, joined the governing body; this indicated a commendable family association. It was interesting to note the wide vision of the founders, who had included in the scheme not only educational and technical studies, but also cultural and recreative activities. Under the Education Act, 1944, it became a duty for the local education authority to secure the provision of these facilities; the Government would support the development, but was also anxious at the same time to preserve the best of the old voluntary spirit which had contributed much to the Polytechnic. One proof of the vitality of the Polytechnic was that its home had never been big enough. It was to be regretted that before the War greater effort had not been made to put up more capacious buildings. At present the lack of building and shortages of labour and materials were obstacles, and the Polytechnic would for a time have to house as best it could its 1,000 full-time day students, 3,000 part-time students, and 1,000 non-student social members. The provision of social and recreative activities for the latter members was a vital influence which went far beyond the walls of the Polytechnic.

The Northern Polytechnic, Miss Wilkinson remarked, was a pioneer in at least two respects. It had opened the first department for musical instrument technology—and this still appears to be the only one of its kind in the world—and it had inaugurated the first courses in rubber technology. In the case of the course in rubber technology, the Ministry of Education is anticipating a further development in the establishment of a National College of Rubber Technology to provide advanced courses and to serve the rubber industry of Great Britain.

During the War, the Northern Polytechnic, with its existing radio course, was called upon early in October 1939 to train men in radio for the Services, and more than 2,000 Service men and women received instruction to meet the urgent demand for technically trained personnel. The demand continues in this world of rapid industrial and scientific change, and the Polytechnic with its great past and its wonderful traditions is fully conscious of the great opportunities for future service to the locality and to the country.

Mr. R. L. Roberts, chairman of the governors, said in reply that he could look back over almost the whole of the jubilee period, for he was an evening student in 1898, when the Northern Polytechnic provided numerous courses on a large variety of subjects. It is no longer a polytechnic in that sense. It is now a college of technology, as its activities had been concentrated into four main sections: first, architecture, surveying and building; secondly, science and rubber and plastics technology; thirdly, radio and musical instrument technology; and fourthly, domestic science.

In all the courses the governors have pursued a policy of effective contact with industry through influential advisory committees. The close association for more than forty years with the University of London through the 'recognized teachers' is of benefit to both the staff and the students. A similar close contact is maintained with the professional organisations, such as the Royal Institute of British Architects, which has recognized the five years full-time course in architecture at the Polytechnic. The main difficulty in the Polytechnic is still one of accommodation, and the governing body hopes that when the building industry is able to direct its activities to national needs other than housing, an extension will be built worthy of the Polytechnic and capable of meeting its needs for some time. There is one further difficulty, which other similar institutions must feel, namely, staffing. The Burnham

Committee had not accepted the recommendations in the Percy and McNair Reports, nor have the salary scales justified the belief of the Minister that they would make it possible to maintain a high standard of staffing. Shortage of man-power has played only a secondary part; the fact is that the salary scales are not sufficiently attractive to induce the best teachers to accept employment in colleges such as the Northern Polytechnic, where the standard of education is high. Possibly the Minister might consider seeking further advice on this matter from the Burnham Committee.

Finally, the Ministry of Education, London County Council, Middlesex County Council and City Parochial Foundation were thanked for their generous support of the educational, technical, social and recreative activities of the Polytechnic. The activities of colleges of this standard must undoubtedly expand during the forthcoming years if the industries and commerce of Britain are to attain that degree of efficiency essential in a highly competitive world.

FLATFORD MILL FIELD CENTRE

THE first report of the warden of the pioneer centre at Flatford Mill of the Council for the Promotion of Field Studies shows how much has already been achieved. This centre opened to receive students on May 25, and closed on September 30. During this period 339 students or visiting staff came into residence—118 men, 221 women—or attended daily (29 on approximately twenty occasions). Of the visiting students and staff, 102 stayed for three days or less; 157 stayed for between three days and a week; 40 stayed for between a week and a fortnight; 11 stayed for longer than a fortnight; and 29 attended daily. 217, coming as members of classes, were eligible for university or other educational authority grants-in-aid; 122 came independently, that is, about one third were independent scientific workers or artists ineligible, so far as is known, for any official grant-in-aid. It would seem, therefore, that a field centre provides a long-wanted opportunity for the 'independent amateur'. The relative numbers of the various groups of students and staff were as follows: visiting teaching staff, 36; university students, 19; teachers (attending courses or in other official capacity), 57; training college students, 53; school students, 53; independent students (*a*) "of research status", 62; (*b*) "of amateur status", 40 (total 102, of whom 28 were artists—21 in *a*, 7 in *b* status); other "interested visitors", 19.

In many cases the students' interests and activities were by no means confined to one particular study, but the following figures will give some indication of the relative divisions into the various field studies undertaken: artists, 36; history and archæology, 8; geology, 10; geography, rural science and social studies, 41; geography and biology, 40; general biology, 123; botany, 37; entomology, 11; birds, 21.

The work, under the immediate direction of the warden or in most cases when visiting staff were present with his co-operation, has been largely exploratory; stress has been laid upon methods of tackling field work and outdoor class instruction rather than upon organising detailed research or record-hunting. The difficulties of obtaining essential field apparatus, and perhaps, above all, the multifarious demands upon the warden's time with parts of the premises constantly in the builder's hands, have prevented as close an investigation of the area as might otherwise have been undertaken. In the laboratory the main concern has been with the demonstration of simple techniques and use of apparatus, the recording of field data, and identification. Field work has been pursued in many branches. It is hoped that the centre will re-open towards the end of next March and be able to take an increased number of students.

Further information can be obtained from the Secretary, Council for the Promotion of Field Studies, Mr. F. H. C. Butler, Ravensmead, Keston, Kent.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 11

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.15 p.m.—Mr. A. Jacob: "Handling Material in Bulk by Weight".

Tuesday, November 12

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. H. T. A. Sharpe: "Economic Telephone Exchange Area Planning".

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. James Gray, F.R.S.: "Locomotory Mechanisms in Vertebrate Animals, 3, Locomotory Mechanism in Typical Tetrapods; Limbs as Co-ordinated Struts and Levers".*

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. G. F. Wood, Dr. Alfred H. Nissan and Dr. F. H. Garner: "Viscometry of Soap-in-Hydrocarbon Systems".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Prof. Alejandro Lipschutz: "Results of a Recent Expedition to Tierra del Fuego".

Wednesday, November 13

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Manchester), at 2.30 p.m.—Dr. E. S. Grumell and Dr. A. C. Dunningham: "The Distribution of Ash in British Coals and its Bearing on the Economics of Coal Cleaning".

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (at the Science Museum, Exhibition Road, London, S.W.7), at 4.30 p.m.—Second Annual General Meeting. Discussion on "The Cultivation of a Thermodynamic Outlook" (to be opened by Sir Charles Darwin, K.B.E., F.R.S.).

CHEMICAL SOCIETY, LIVERPOOL SECTION (in the Chemistry Lecture Theatre, The University, Liverpool), at 5 p.m.—Dr. H. W. Thompson, F.R.S.: "Some Applications of Infra-red Measurements".

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5 p.m.—Mr. R. W. Lacey: "Aspects of Cotton's War Effort".

GEOLOGICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. C. T. Trechmann: "Coastal Uplift and Glacial Problems in East Durham"; Mr. W. N. Edwards (on behalf of Mr. W. Kuhne) will exhibit remains of Early Mesozoic Mammal-like Reptiles from Fissures in the Carboniferous Limestone of Somerset.

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. T. R. P. Harrison: "The Development of the Gas-Cushion Cable System for the Highest Voltages".

INSTITUTION OF CIVIL ENGINEERS, NORTH-WESTERN ASSOCIATION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. D. I. Richards: "The Application of Soil Mechanics to Highway Construction".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—"Decolourisation by Vegetable Carbons". (Mr. L. Wickenden: "The Percofil Process"; Mr. D. Ramondt: "The Collactivit Process".)

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Bolbec Hall, Newcastle-upon-Tyne 1), at 6.45 p.m.—Mr. P. D. U. Fraser-Smith: "Variable Pitch Propellers".

WOMEN'S ENGINEERING SOCIETY (at 35 Grosvenor Place, London, S.W.1), at 7 p.m.—Dr. K. Lonsdale, F.R.S.: "The Engineer and the Crystal".

Thursday, November 14

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 11 a.m.—Discussion on "Engineering Problems of Future Aircraft".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting. Dr. A. G. Walker: "Geometry and Cosmology".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. J. R. Partington: "History of Alchemy and Early Chemistry, 3".*

INSTITUTION OF ELECTRICAL ENGINEERS, INSTALLATIONS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p m —Mr W. Fordham Cooper. "Electrical Control of Dangerous Machinery and Processes".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester 2), at 6 30 p m.—Mr. J. S Taylor · "Textile Engineering".

ROYAL PHOTOGRAPHIC SOCIETY (joint meeting of the SCIENTIFIC AND TECHNICAL GROUP and the COLOUR GROUP, at 16 Princes' Gate, London, S.W 7), at 7 p m —Dr. H. V. Walters "Colour and its Reproduction" ("How it Works in Colour Photography", 1)

SOCIETY OF DYERS AND COLOURISTS, WEST RIDING SECTION (at the Great Northern Victoria Hotel, Bradford), at 7 15 p m.—Mr. G. G. Simpson · "The Selection of Dyes for covering Wool which has been Exposed to Light".

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (joint meeting with the NATIONAL ASSOCIATION OF WOMEN PHARMACISTS, in the Lecture Theatre, St. Mary's Hospital, Manchester), at 7 45 p m —Mr H. Gartside "Pharmacy in Germany and Spain".

Wednesday, November 13—Thursday, November 14

IRON AND STEEL INSTITUTE (at the Institution of Civil Engineers, Great George Street, London, S W.1) —Autumn Meeting.

Wednesday, November 13

At 10 a.m. and 2 30 p.m.

Thursday, November 14

At 9 30 a m. and 2 30 p m

Friday, November 15

CHEMICAL SOCIETY, ST ANDREWS AND DUNDEE SECTION (joint meeting with the ST. ANDREWS UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, United College, St Andrews), at 5 p.m —Prof. F. S. Spring: "Applications of the Hofmann Reaction to the Synthesis of Heterocyclic Compounds"

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S W 7), at 5 p m —Dr O Klemperer "Electron Optics and Space Charge in Strip-Cathode Emission Systems"; Dr W J. G. Beynon: (a) "The Application of Ionospheric Data to Radio Communication Problems", (b) "Oblique Radio Transmission in the Ionosphere and the Lorentz Polarization Term", (c) "Some Observations of the Maximum Frequency of Radio Communication over Distances of 1,000 km and 2,500 km.".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5 30 p.m.—Dr H J. Gough, F R.S.: "Research and Development Applied to Bomb Disposal" (Thirty-third Thomas Hawksley Lecture).

ROYAL INSTITUTE OF CHEMISTRY (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 6 p m.—Mr. J. C. Withers. "The Chemist as Information Officer" (Twenty-ninth Streatfeild Memorial Lecture).

SOCIETY OF DYERS AND COLOURISTS, MANCHESTER SECTION (joint meeting with the LOCAL SECTIONS OF THE ROYAL INSTITUTE OF CHEMISTRY, THE CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and THE TEXTILE INSTITUTE, in the Lecture Theatre of the Gas Show Rooms, Town Hall, Manchester), at 6.30 p.m —Prof E. L. Hirst, F.R.S., and Dr. J. K. N. Jones: "Gums and Thickening Agents"

PAPER MAKERS' ASSOCIATION (TECHNICAL SECTION), NORTHERN DIVISON (at the Engineers' Club, Manchester), at 7 p.m.—Mr W. S. Baskerville: "The Place of Fuel in the National Economy of the Country".

TEXTILE INSTITUTE, MIDLANDS SECTION (at Leicester), at 7 p.m — "Specific Uses of Wool and Cotton Yarns" Mr. G. Fielden · "Worsted Yarns"; Mr. J N. Simpson: "Cotton Yarns"; Mr. Alan Bax: "Knitwear Manufacture".

CHEMICAL SOCIETY, GLASGOW SECTION (in the Chemistry Lecture Theatre, The University, Glasgow), at 7.15 p.m.—Prof. A. R. Ubbelohde: "Melting and other Phase Changes".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. G. M. Trevelyan, O.M.: "Society in Roman Britain".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SUPERINTENDING PHARMACIST at the Royal Air Force Medical Equipment Depot, Chessington—The Under-Secretary of State, Air Ministry, S.2(q), Cornwall House, Waterloo Bridge Road, London, S.E.1 (November 14).

LECTURER IN INORGANIC CHEMISTRY, and a LECTURER IN FUEL TECHNOLOGY—The Principal, Heriot-Watt College, Edinburgh (November 15).

LECTURER IN THE DEPARTMENT OF CHEMISTRY (to teach mainly Organic with some Physical Chemistry) at Leeds College of Technology —The Director of Education, Education Offices, Leeds 1 (November 16).

LECTURER IN BACTERIOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (November 16).

LECTURER IN ORGANIC CHEMISTRY—The Registrar, King's College, Newcastle-upon-Tyne (November 16).

RESEARCH ASSISTANTS (4) for routine analysis, etc., as members of a team studying plankton ecology in relation to the fisheries—The Head of the Department of Oceanography, University College, Hull (November 16).

LECTURER IN THE DEPARTMENT OF BACTERIOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (November 16).

PRINCIPAL of the Old Swan Technical Institute—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (November 18).

SENIOR SCIENTIFIC OFFICER (temporary), and an ASSISTANT EXPERIMENTAL OFFICER (temporary), in the Royal Air Force Acoustics Laboratory—The Under-Secretary of State, Air Ministry, S 2(q), Cornwall House, Waterloo Bridge Road, London, S.E 1 (November 18)

READERSHIP IN GEOGRAPHY tenable at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W C 1 (November 19)

LECTURER IN ELECTRICAL ENGINEERING at Cape Technical College, Cape Town—J. A Ewing and Co (London), Ltd, Finsbury Court, Finsbury Pavement, London, E C 2 (November 20)

PRINCIPAL SCIENTIFIC OFFICER in the Radar Research and Development Establishment of the Ministry of Supply at Malvern, Worcs — The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1671 (November 21)

LECTURER (Grade II) and an ASSISTANT LECTURER (Grade III) in the Department of Geography—The Registrar, The University, Liverpool (November 22).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Sheffield (November 23)

DEMONSTRATOR IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College for Women, Regent's Park, London, N W.1 (November 25)

READERSHIP IN MATHEMATICAL STATISTICS tenable at Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C 1 (November 26).

HEAD OF THE DEPARTMENT OF SCIENCE AND ELECTRO-TECHNICS, HEAD OF THE MATHEMATICS DEPARTMENT, SENIOR LECTURERS AND LECTURERS IN SCIENCE (PHYSICS, CHEMISTRY, ENGINEERING), at the Royal Military Academy, Sandhurst—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1677 (November 28).

SCIENTIFIC OFFICER (engineer or physicist) to take charge of work on Automatic Controls at the National Physical Laboratory—The Secretary, Civil Service Commission, Burlington Gardens, London, W 1, quoting No. 1661 (November 28)

PRINCIPAL OF THE WANDSWORTH TECHNICAL INSTITUTE, High Street, London, S W.18—The Education Officer (T.1), County Hall, London, S.E.1 (November 30).

LECTURER IN WEST AFRICAN LANGUAGES at the School of Oriental and African Studies—The Secretary, University of London, Senate House, London, W.C.1 (November 30)

LECTURER and an ASSISTANT LECTURER IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Leeds 2 (November 30).

PROFESSOR OF AGRICULTURE—The Registrar, University of Queensland, Brisbane, Qd, Australia (air mail, November 30).

ASSISTANT EXAMINERS in the Patent Office under the Board of Trade—The Secretary, Civil Service Commission, Burlington Gardens London, W 1, quoting No. 1664 (December 1)

CHAIR OF BOTANY, CHAIR OF LECTURESHIP IN GEOGRAPHY, and the CHAIR OF PHYSIOLOGY, in the University of Ceylon—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (December 10).

LECTURER IN PHYSICS at Makerere College, Kampala, Uganda—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (December 10).

SENIOR LECTURER IN PHYSIOLOGY in the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C 2, quoting G.83 (December 12).

PRINCIPALSHIP of the Gordon Memorial College, Khartoum—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (December 13).

LECTURER IN AGRICULTURAL CHEMISTRY—The Registrar, University of Queensland, Brisbane, Qd, Australia (December 31).

PRINCIPAL—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (January 1).

RESEARCH ASSISTANT IN THE PIG HUSBANDRY RESEARCH STATION —The Secretary, Wye College, Wye, Ashford, Kent.

PRINCIPAL OF VICTORIA UNIVERSITY COLLEGE, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

LECTURERS at the Natal University College in APPLIED MATHEMATICS (in Pietermaritzburg), in GEOGRAPHY (in Durban)—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C 1.

DEMONSTRATOR IN BIOLOGY for Department of Anatomy—The Bursar, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1.

SCIENTIFIC OFFICER to run locust breeding laboratory with possibility of research, a TECHNICAL ASSISTANT in the locust laboratory, and a TECHNICAL SECRETARY—The Director, Anti-Locust Research Centre, British Museum (Natural History), Cromwell Road, London, S.W.7

JUNIOR TECHNICIAN in an organic chemical research laboratory—The Administrative Officer, National Institute for Medical Research, Hampstead, London, N.W.3.

GRADUATE CHEMIST—The Secretary, British Coal Utilisation Research Association, 13 Grosvenor Gardens, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Bernice P. Bishop Museum. Bulletin 183: Songs of Uvea and Futuna. By E. G. Burrows. Pp. 122. Bulletin 185: The Native Culture of the Marianas Islands. By Laura Thompson. Pp. 48 + 3 plates. Bulletin 186: Report of the Director for 1944 By Peter H. Buck (Te Rangi Hiroa). Pp. 44. (Honolulu: Bernice P. Bishop Museum, 1945.) [174

Colony and Protectorate of Kenya. Forest Department Annual Report for the Year 1944. Pp. 14. (Nairobi: Government Printer, 1946.) [234

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MATHEMATICAL TECHNOLOGY OR QUANTITATIVE MATHEMATICS

WE publish in this issue an article by A Erdélyi and John Todd, entitled "Advanced Instruction in Practical Mathematics", which follows an earlier article by D. H. Sadler and John Todd (*Nature* of May 4, p. 571), "Mathematics in Government Service and Industry: some Deductions from the War-time Experience of the Admiralty Computing Service". They claim that it has now been fully demonstrated that there is a need, in Government departments such as the Admiralty, the Ministry of Supply and Aircraft Production, and in industrial research associations or research departments of engineering or other firms, for a new type of mathematician, whom Dr. N. W. MacLachlan has called a 'mathematical technologist'. Such a man will have a good knowledge of academic mathematics, but in addition will know how to apply this knowledge to obtain a complete approximate solution, with full numerical calculations, of an engineering or other problem. Much of modern academic mathematics is of a qualitative nature. We prove that a solution of a problem exists, under certain conditions, and that this solution has certain properties, such as breaking down at specified exceptional points. The mathematical technologist will not be ignorant of this, but will supplement it with detailed quantitative knowledge, giving all the information required to any desired degree of approximation. So far the universities of Great Britain have done little or nothing to produce such men. What should be done about it?

Before considering the proposals put forward by Mr. Todd and others, all of whom agree in their general objects, we must face the fact that many mathematicians of the greatest eminence will view such proposals with reluctance. For example, Prof. G. H. Hardy, the acknowledged leader of British pure mathematics, to whom most of the ablest young mathematicians have, for many years, looked for guidance and inspiration, divides mathematics into "real" and "trivial" ("A Mathematician's Apology", Cambridge, 1940). By real mathematics he means that which has permanent æsthetic value, for example, the best Greek mathematics. This mathematics "is eternal because the best of it may, like the best literature, continue to cause intense emotional satisfaction to thousands of people after thousands of years". Such mathematics includes not only Fermat's investigations into the theory of numbers and other work in pure mathematics, but also Einstein's theory of relativity, and Dirac's quantum mechanics. On the other hand, Prof. Hardy describes as "trivial" nearly everything that could be called laboratory mathematics, such as the work of gunnery experts and aeroplane designers. He admits that ballistics and aerodynamics demand a quite elaborate technique, so that it is perhaps hard to call them "trivial", but they are described as repulsively ugly and intolerably dull. It is not quite clear how far Prof. Hardy has been influenced by his appreciation of beauty, and how far by his dislike of war. Plato, on the other hand, advocated the study of geometry not only for its permanent æsthetic value, but also for its usefulness in war. Both Plato and Prof. Hardy agree in disliking practical or mechanical applications. Plato would leave these to an inferior class without political rights, and Prof. Hardy to the garage mechanic. Really the Greeks were the more logical, for the philosopher cannot exist without the productive efforts of either slaves or of the machine. It is not contempt of human values, but a deep respect for them, that leads us to develop the machine as the only way of making possible a tolerable life for all. To develop the machine we need the technologist, and every branch of science must be called upon to make its contribution to human well-being.

But this contribution need not be a sacrifice without hope of reward, even from the point of view of abstract thought. Archimedes, the greatest mathematician of ancient times, who turned his attention to ballistics when it was necessary to defend his homeland against the invader, opened up many new and fruitful lines of development of mathematical theory. His genius was apparent in his disregard for the narrow limitations laid down by Plato. Gauss, "the prince of mathematicians", is revered for his researches in the theory of numbers and other branches of pure mathematics; but he was also greatly interested in calculating the orbit of the planet Ceres. His interest in practical surveying led to his beautiful theoretical researches on the differential geometry of surfaces. Why should any mathematician think it degrading to follow in the footsteps of Archimedes or Gauss?

We have thought it worth while to deal, at some length, with the possible *a priori* objections to the proposals of Mr. Todd and others, before examining in detail the proposals themselves, because once the desirability of the existence of mathematical technology is admitted, the case they make out can scarcely be denied. They point out that the need for training in computational mathematics was emphasized by the Assistant Director of Scientific Research in the Admiralty in 1942. Earlier in the War, great assistance had been given to the Admiralty and to other Government departments by the Nautical Almanac Office. When the work continued to expand, Mr. Sadler, superintendent of that Office, was called in to make an investigation, and made proposals which eventually led to the formation of a Mathematics Division of the National Physical Laboratory. This will be a permanent organisation, for peace as well as for war.

The question arises how the permanent senior staff of such an organisation are to be trained. To a certain extent, good mathematicians could pick up the technique by actual experience in the National Physical Laboratory itself. But this is not really satisfactory if new processes are to be devised, for the conditions of work in the Civil Service, especially for work which demands a high degree of accuracy, may not be the most suitable for innovations or research. Moreover, there are the somewhat similar needs of workers in any of the increasingly numerous industrial research associations. It would seem that systematic courses in the subject, such as could be offered by a university or institute of similar standing, would best meet requirements.

The greatest mathematical centre in Great Britain is the University of Cambridge; and it now has a Mathematical Laboratory, which is reasonably well equipped, and active workers who understand the importance of mathematical technology. It is not too much to hope that a flourishing post-graduate school may grow out of the work of this Laboratory. There is also the Imperial College of Science and Technology, London, which, as shown by Prof. S. Chapman's article "University Training of Mathematicians" (*Mathematical Gazette*, **30**, 61; 1946), has a competent staff who have sympathy and experience with work of this sort. It is true that Prof. Chapman was describing a modification of the undergraduate course which has produced good results, whereas Mr. Todd and his associates prefer a post-graduate course in computation following an honours course in mathematics of the usual type; but the general point of view is so similar that it should be easy to devise concerted action.

Now that the University Grants Committee has new terms of reference, which empower it to advocate a positive policy, it might well consider the establishment of an institute devoted to mathematical technology or quantitative mathematics. The term "advanced practical mathematics", used by Mr. Todd, has an unfortunate association with instruction in the use of formulæ without proof, sometimes given in technical colleges, and so require careful consideration. In the beginning, at any rate, the organisation should be elastic. In addition to complete courses for those who are desirous of taking a full course of training, there should be short courses to attract mathematicians who, though suspicious, might be willing to investigate a new aspect of their subject. Whether such an institute should publish monographs, or a journal of its own, and how far it should install elaborate calculating machines of mechanical or electronic types, are matters for the future. What does seem clear now is that a start should be made as quickly as possible.

APPEAL TO CLIO

History is on Our Side

A Contribution to Political Religion and Scientific Faith. By Joseph Needham. Pp. 226. (London George Allen and Unwin, Ltd., 1946.) 8*s*. 6*d*. net.

UNDER the title "History is on Our Side", Dr. Joseph Needham has brought together twelve essays and addresses written or delivered between 19[illegible] and 1942, some of which were revised during his stay in China. Most of them display the omnivorous character of Dr. Needham's reading, and some of them have the charm and persuasiveness that marked his earlier book, "Time: the Refreshing River". But in spite of a certain spiritual quality, they are rarely so convincing as his earlier book. They lack unity and the book as a whole is a rather confused mixture of science, politics, religion and philosophy in which the enthusiasm of a convert has warped the judgment and critical faculty that one would expect of a scientific man of Dr. Needham's standing. Dogmatism and a tendency to *ex cathedra* judgments rob the book of any pretensions to form a serious contribution to either political or religious thought: one is left no wiser at the end as to what 'political religion' may be, or 'scientific faith'.

The happiest of these essays is that entitled "Cambridge Summer", where Dr. Needham not only displays his wide erudition but also an imaginative insight that gives his essay a real charm. Elsewhere, too, Dr. Needham shows a real power to interpret the past and give it new meaning, and more especially when his interest lights on some forgotten figure and brings it to life again. But the historian who would welcome Dr. Needham's talent as a historical interpreter would be appalled at the inaccuracy of his quotations, and the ease with which his enthusiasms or prejudices lead him to throw to the winds the old Cambridge tradition of exact learning and cautious statement. It was not Lord Stamp but the Bishop of Ripon who suggested a moratorium for scientific discovery, although abbreviated press reports of Lord Stamp's words have conveyed that impression. Similarly, Dr. Needham confuses Johnson's well-known refutation of Bishop Berkeley's "ingenious sophistry" with the dictum of David Hume that Berkeley's arguments "admit of no answer and carry no conviction". "A letter to an American Friend" entitled "University Democracy" also shows imagination, and its vigour and earnestness make it even after eight years a stimulating contribution to current debate on the future universities. The same cannot be said of the Schiff Lecture at Cornell University in 1940, "The Nazi Attack on International Science". Effective propaganda when written no doubt, in spite of a rather superficial and unconvincing analysis of the havoc in German science, this essay is dated and the connexion with the others is slight.

These three essays occupy almost half the book, and it is in the remaining essays such as those entitled "The Two Faces of Christianity", "History is on Our Side", "Religion and Politics", that Dr. Needham's bold incursions into religion and philosophy, or indeed into physics, are most provocative. Indeed, if it can be said of them that they frequently fail to convince, they certainly admit of an answer. Startlingly rapid argument, for example, in an essay "The Liquefaction of Form and Matter", leads Dr. Needham to conclude that "we can stop thinking of Form and Matter altogether if we begin thinking of Organisation and Energy". Dr. Needham passes far too lightly over the difficulties that yet remain, and his omissions no less than his assertions might provoke a devastating reply from a physicist. Nor where he should be more at home, as in his essay "The Gist of Evolution", is Dr. Needham altogether free from such faults. A fervent adherence to his creed of dialectic materialism betrays him into overstatement or over-simplification and a neglect of the arguments on the other side which rob this book of claim to be a real contribution to serious thought.

When this has been said, it remains true that, without establishing his thesis convincingly, Dr. Needham gives something more than an interesting study of his enthusiasms and prejudices. Through the book there is woven a moving and human picture of communism and the ideal it represents. The picture may be overdrawn and not entirely accurate, and there is an absence of the hard thinking and unfailing accuracy that are necessary to carry conviction. Dr. Needham's profound admiration for Soviet Russia pervades the book, although the basis of that admiration is never very clear. He believes that in essentials Soviet Russia has shown the way to the moral regeneration required to establish a world community. He states the contrast between evolutionary progress and retrogression in terms of the Fascist–Communist antithesis, but there is no analysis of the difference between the two different conceptions of democracy that tend to divide the post-war world. Again, although he sees communism as the successor and heir of "Christian materialism", he fails to recognize the nature of the Christian attempt to reconcile individual consciousness and initiative with social responsibility, or that the essential problem before us to-day is whether the individual can preserve his integrity within a collectivist society. The recent literary purge at Leningrad betokens stirrings towards intellectual freedom which do not suggest that the creative instincts, whether in art or in science, have quite the play that Dr. Needham would have us believe. That physical order is everywhere decreasing and biological and social organisation increasing; that the whole enterprise of science is a manifestation of social organisation; that the world co-operative commonwealth is a certain resolution of our difficulties, are large assumptions which may possibly be true, though they can scarcely be described as having the full authority of evolution behind them, at least on the evidence Dr. Needham presents. We may agree with Dr. Needham that the achievement of some new and closer form of world order by man's conscious effort to modify his environment and his relations with his fellows is the condition of survival; but not all the charm of Dr. Needham's essays, his rich illusiveness, and deep human concern quite convince the reader that he has pointed the way to solve the problem.

R. BRIGHTMAN

ELECTRON OPTICS FOR STUDENTS

Introduction to Electron Optics

The Production, Propagation and Focusing of Electron Beams. Dr. V. E. Cosslett. Pp. xii+272+8 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 25*s.* net.

It was a surprise to read in Dr. Cosslett's preface that a course of lectures in electron optics has been given in the honours physics course at Oxford since 1942; yet the surprise was unwarranted because the War has forced electron optical devices out of the laboratory and into industry and the Services. Dr. Cosslett has aimed at providing a text-book "intermediate in length and level of treatment", and hopes that it will be of use to students and research workers; presumably those using electronic devices rather than their designers.

The first half of the book is devoted to the theory of electrostatic and magnetic lenses together with their aberrations. After a brief introductory chapter dealing with the elements of electron motion in electromagnetic fields, the author considers methods of determining electrostatic field distributions and ray paths. Besides the standard material on analytical methods, electrolytic troughs and rubber sheet models, a short account of the application of Southwell's relaxation method is included. This method has not been widely used, and one would like to know whether it is a better tool than, say, the electrolytic trough. Separate chapters on electrostatic focusing and magnetic focusing follow. These chapters contain some new material by the author and his colleagues on the numerical computation of focal lengths. The matter is well balanced, and the methods of ray tracing described are well suited to the needs of the learner, although few specialists will find their pet techniques described. The section ends with a treatment of aberrations which is one of the best parts of the book, Dr. Cosslett having steered a straight course between the Scylla of obscurity and the Charybdis of superficiality.

The second half of the book deals with the application of the theoretical principles already discussed to various electron optical devices commonly used in research and industry to-day. The different types of electron emission are first briefly discussed; next comes a chapter on cathode ray tubes and picture converters; electron diffraction and electron microscopes share another, then cylindrical field devices including the β-ray spectrograph, magnetron, cyclotron, betatron, beam testrodes and mass spectrographs are summarily described in eighteen pages. Velocity-modulated beams occupy the last chapter, and the book is rounded off by an appendix on the Hamiltonian optics. Clearly it is quite impossible to deal adequately with this mass of material in a hundred or so pages, and one must express a doubt as to whether the needs of the student are best served by such inclusiveness. The level of these discussions is very variable, and it is quite obvious where the interests and practical experience of the author lie. For example, the discussion of beam tetrodes and magnetrons is too brief to be convincing, and some distortions of fact have crept in; thus, a remark at the end of the section on beam tetrodes implies that in general they possess mutual conductances several times greater than pentodes, which is certainly not the case. The description of magnetron operation in the dynatron regime given on p. 220 is confused.

The short chapter on velocity modulation devices does not include any recent material, but allowances must be made for the fact that the book has been rather a long time in printing (the preface is dated April 1945); although other sections contain references to the Smyth Report on atomic energy.

It is unfair to criticize the book on specialist grounds. It is obvious that a text-book of this type must contain material on the practical application of the subject if it is to grasp the student's interest, and no individual could write authoritatively on all the subjects considered. One major criticism is unfortunately necessary. There are two main divisions in modern electron optics; the first, to which the book is confined, is light-current optics, in which the electrons travel along paths prescribed by fields external to the beam. In heavy-current electron optics, the electron motion is also a function of the space-charge fields set up inside the beam, and, in fact, space-charge conditions determine the maximum current which can be passed through any electronic device. The electron optical design of a klystron is far less a question of providing specified focal lengths than it is of providing specified currents, and it was only when designers forgot about cathode ray tube gun designs that much progress was made. Dr. Cosslett just mentions the pioneer work of J. R. Pierce on these lines, but he misinterprets it by saying that Pierce's treatment neglects space-charge effects, whereas Pierce actually investigates field conditions at a boundary between a region in which rectilinear space-charge flow occurs, that is, in which Poisson's equation is obeyed, and a region in which Laplace's equation is obeyed. Pierce then provides electrodes shaped so as to produce the desired fields. This omission is a major blemish on the book, because a good deal has been published on space-charge flow in various tube geometries, and the subject is just as important technically as light-current optics. It is to be regretted that the book does not use M.K.S. units, which save endless numerical mistakes, especially when high-frequency effects have to be considered.

In spite of these criticisms, Dr. Cosslett has written a useful book—more useful than some much more pretentious works on the subject—and a careful student could learn a great deal from it. Electron optical specialists will not find much of interest, but non-specialists who use electronic apparatus may find the sections on applications stimulating.

A. H. BECK

THE UNIVERSITY AND SOCIETY

Mission of the University

By José Ortega y Gasset. Translated with an Introduction by Howard Lee Nostrand. (International Library of Sociology and Social Reconstruction.) Pp. v+81. (London: Kegan Paul and Co., Ltd., 1946.) 7s. 6d. net.

IN an earlier work, "The Revolt of the Masses", Señor Ortega singles out as one of the most dangerous phenomena of our times the deliberate refusal on the part of the masses to shoulder the enormous burden imposed by the increasing specialization of knowledge. As a result, European man has become 'atomized', and the nineteenth century universities have added to the disintegration by producing "The new barbarian, the professional man". In the present essay, the university is called upon to undertake the work of re-integration. To do this, the university must be completely remodelled, and the most valuable part of the essay consists in a rather sketchy draft of how this is to be done. The new university will be an institute for higher education for the ordinary man. Its core will be a faculty of culture where every student will receive an education designed to put him "at the height of the times", that is, familiar with the vital system of ideas of the period. This education is to be a synthesis of physics (more widely conceived than is usual in Britain), biology, history, sociology and philosophy. In addition, he would be trained "by the most economical, direct and efficient methods" to be a good professional.

These ideas were first expounded in a series of lectures given in 1930 to students in Madrid, and in some respects are relevant only to conditions then prevailing in Spain. To some extent also they represent Ortega's reaction against the over-specialization he found in the German universities, especially in science. But there is enough of general interest to make this a valuable contribution to the continuing debate on the role of the university. Its value would have been greatly increased had the author developed it into the course on the idea of the university spoken of in his preface. For it is easier to agree with his diagnosis of the maladies of universities than with the cure proposed. So many questions are left unanswered. Who is to draw up the synthetic curriculum, and whence will its teachers come? How to ensure that the education which was "at the height of the times" when the student received it is not an intellectual millstone when he is thirty years older ? Such names as Aristotle and Thomas Aquinas remind us that the best of syntheses have an awkward tendency towards fossilization rather than dynamic evolution. Moreover, with all its defects, the nineteenth century university, in Britain at least, had two great merits. In its humane studies, especially in the classics, it gave what has been called "the constant vision of greatness", while in the natural sciences the student was able to watch at first-hand the actual advance of knowledge. Indeed, at the best, both these high virtues might be combined in either discipline, but it is hard to see their place in Ortega's university.

The author has nothing to say on literary or linguistic studies, nor on fine arts, which would seem to be mere appendages of history, and so far as the sciences are concerned the student would be dangerously far from the fountain of knowledge. The English university teacher would not, on the whole, be inclined to welcome a university "centred on the student", and he will surely pray to be delivered from the science of university pedagogy for which Ortega calls. None the less, the plea that the university should show more care for general culture is one that we must not lightly neglect. In his final paragraph, where he calls upon the university to intervene in current affairs, treating the great themes of the day from its own point of view, cultural, professional and scientific, Ortega seems to point to the possibility of the university realizing much of its mission of general culture through its extramural work. The English universities—too narrowly preoccupied in the past with "Workers' Education"—have only begun to address themselves to this task. D. R. DUDLEY

STATISTICS IN INDUSTRIAL RESEARCH

Industrial Experimentation

By K. A. Brownlee. Pp. 116. (London: H.M. Stationery Office, 1946.) 2*s*.

NOT the least of R. A. Fisher's contributions to statistical science has been his insistence that the statistician is as necessary in the planning of experimentation as in the interpretation of its results. In experimental biology, the importance of giving due weight to statistical considerations is now widely recognized, and the intimate connexion between the design of an experiment and the appropriate method of statistical analysis is emphasized in many text-books. Important recent developments of statistical method have arisen in response to the needs of agricultural experimentation : published accounts have described their advantages and illustrated their working chiefly in relation to agricultural or other biological problems. The value of principles such as factorial design, or of techniques such as the analysis of variance, however, is by no means restricted to the elucidation of biological problems.

Mr. K. A. Brownlee presents examples of the application to industry of methods well known in biological research ; both statisticians and industrial research workers should be grateful to him for his attempt to increase their collaboration. He rightly emphasizes the importance of consultation with the statistician before an experiment is begun as well as during the analysis of the results, a policy which, if consistently followed, would lead to greater efficiency and economy of effort in the conduct of many experimental programmes.

After introductory remarks on fundamental statistical concepts of probability distributions and variability, Mr. Brownlee shows the use of elementary significance tests in comparing two sample means or variances. Two short chapters contain discussions of contingency tables and χ^2 tests, and of the Poisson distribution (the binomial distribution is omitted). The remaining two-thirds of the book are concerned primarily with the analysis of variance, especially in relation to factorial experiments and, to a lesser extent, with regression and correlation. Methods of quality control are mentioned, but only briefly, since Mr. Brownlee's subject is experiment rather than routine production. Each type of analysis is illustrated, with considerable arithmetical detail, by examples of its application.

Unfortunately the book, so good in intention, is much less satisfactory in execution. The systems of computation for many of the simpler techniques may be learnt rapidly, but without some critical appreciation of their meaning they may easily be misapplied ; even a statistical 'cookery-book' needs to appeal to the reader's critical faculty as well as to his arithmetical facility. Mr. Brownlee gives very full instruction in calculation, but often seems to suggest that application of inflexible (and sometimes apparently arbitrary) rules is sufficient for the interpretation of experimental data. Furthermore, the description of the subject-matter of many examples is so condensed that the reader unfamiliar with this particular field of industrial experimentation (the manufacture of explosives) may not readily see the relevance of the methods to his own problems.

The section on the comparison of two samples revives unnecessarily the practice of making arbitrary distinction between 'small' and 'large' samples; the trivial simplification in computation resulting from the 'large sample' rule is more than counterbalanced by its confusion of the reader who does not realize that one rule is an approximation to the other. The discussion of correlation and regression is useful so far as it goes, but it is marred by complicated notation, and the existence of further extensions of the methods is not mentioned ; the statement of the fiducial limits of a regression equation takes no account of errors in the estimated regression coefficient, and no distinction is drawn between the precision of prediction of a single value and that of the mean value of the dependent variate for a given value of the independent variate. In his main chapter on the analysis of variance, Mr. Brownlee first tests the significance of high-order interactions, and pools non-significant components with the error sum of squares ; he then tests interactions of lower order against the new error mean square, and continues the pooling process. Though pooling of components in this way may occasionally be excused, it will tend to produce under-estimation of error mean squares, and its general adoption might lead to serious biases in tests of significance. The whole of this chapter exemplifies the uncritical presentation of the subject, for the analysis of variance is shown as an entirely automatic method of interpreting data. In the account of factorial experiments, no mention is made of factors at more than two levels, and, in spite of their detailed description, the methods of computation shown are not always the most expeditious.

Apart from faults in theory such as have been noted in the previous paragraph, the chief reason why this book fails to satisfy is that its aims are too many. It appears to be intended as a general description of the potentialities of statistical science in industrial experimentation, as an elementary manual of instruction, and also as an introduction to the use of various more advanced analytical techniques. Whether the combination of these within a single book is desirable may be doubted; its successful accomplishment in 116 pages is impossible.

D. J. Finney

MEDICAL ENTOMOLOGY

Entomology (Medical and Veterinary)
By Prof. D. N. Roy. Pp. xii+358. (Calcutta: Saraswaty Library, 1946.) 30 rupees.

THE author of this book is professor of medical entomology in the Calcutta School of Tropical Medicine. His object in writing it, he informs us, is to ease the scarcity of works of a technical nature now available in India. It is intended for the use of medical and veterinary students as well as for public health officials, all of whom require up-to-date information on insects in relation to disease. It is a matter of interest that the book has been written, printed, illustrated and published in India by Indians.

As is usual in preparing works of this kind, the scope of entomology has been extended so as to include ticks and various other animals that are implicated, in some way or other, with disease transmission. The importance of *Anopheles* mosquitoes in the tropics needs no comment, and this feature accounts for these insects receiving fuller treatment than any of the other groups. Keys and tables for the identification of both the adults and the larvæ are given; methods of conducting malarial surveys and of the preparation of blood-films are explained, and there is an interesting account of the different means for malaria control in its various aspects—chemical, biological or otherwise. The account of Culicine mosquitoes, notwithstanding their great importance from the medical point of view, is much more condensed, and the chapter concludes with a bibliography of about 270 titles.

The Psychodidæ follow, and a short but useful account of the flies is given, with a good bibliography of the relevant literature. A good and, on the whole, adequate account of the Cyclorrhapha as exemplified by the house-fly is given. The habits of all more important species are referred to and the essential details of the most modern methods of prevention and control are provided. The next twenty-four pages deal with the fleas and their relations to bubonic plague, together with certain other diseases. The account of the Anoplura gives the chief facts regarding the medical importance of *Pediculus* and methods of disinfestation. It is interesting to note that the almost incredible number of 9,020 individual lice (adults and immature forms) is recorded from one female patient. Passing over several groups, we come to the ticks and other Arachnida, etc.; the book concludes with a chapter on entomological technique, including section-cutting and staining.

Viewed as a whole, it is a useful volume, well adapted for the purposes intended. The subject-matter is concisely expressed and well up to date. A good feature is the bibliographies at the end of each account. The main criticism is that the author plunges too suddenly into a specialized subject without an adequate preliminary account of insects as a whole. No references are given to general works on entomology, while a short list of the leading textbooks of medical entomology would be useful to the reader who desires to widen his point of view beyond the confines of this book. These omissions, however, are minor features in a good reliable volume, the author of which is to be congratulated on his efforts.

A. D. Imms

PROTOZOOLOGY

Protozoology
By Prof. Richard R. Kudo. Third edition. Pp. xiii + 778. (Springfield, Ill.: Charles C. Thomas, 1946.) 8 dollars.

IT is now fifteen years since Kudo, who occupies one of the very few university chairs of protozoology in the world, produced his "Handbook of Protozoology"; the second edition appeared in 1939, and now a third edition has been issued.

This third edition, much of which has been rewritten, contains two new chapters, one on the major groups and phylogeny of the Protozoa, and one on the collection, cultivation and observation of them. The author, rightly believing that adequate illustrations are important, has added sixty-nine figures, forty-seven of which are new, while twenty-two are taken from his "Manual of Human Protozoa", which was published in 1944. The result is a book which will be valuable to all biologists who wish to study the Protozoa. It is well printed and tastefully produced, but here and there the language is quaint, and there are misprints which could have been eliminated; and the definite article is sometimes omitted. Most of the illustrations are in line and stipple, and the majority are good or excellent. The coloured figures of the human malarial parasites are better than many that have been published. A few of the illustrations, however, are too small The beauty and clarity of Bělař's figure of the pædogamy of *Actinophys sol* on p. 164 have suffered in this way; and students of parasitic Protozoa will feel that the figures of *Crithidia*, *Herpetomonas*, *Giardia*, *Trichomonas*, *Trypanosoma gambiense*, *T. rhodesiense* and of some other parasitic species compare unfavourably with those published in books of medical parasitology.

These are, however, relatively unimportant criticisms. More important is the fact that, in this book, one of the few volumes dealing with the Protozoa from the biologist's point of view, only 176 of the 710 pages are devoted to the general biology of the Protozoa, which raises so many problems of fundamental biological importance. The second part of the book, devoted to taxonomy and special biology, gives some further notes about the biology of some species, but these are notes only. On the other hand, the reader who desires further information about particular points can obtain it by following up the references given at the end of each chapter.

It is likely that this book, like other books of equally wide scope, will grow with the years and become more and more valuable to the biologist.

G. Lapage

Honey Production in the British Isles

By R. O. B. Manley. Pp. 328 + 15 plates. (London: Faber and Faber, Ltd., 1946.) 18*s*. net.

WHEN a modern technical work sells second-hand for considerably more than its published price, there is a clear case for re-issue. The above is substantially a re-issue of the former edition, with errata corrected and some new illustrations.

It is the only book on bee-keeping in Great Britain written by one who depends upon honey production for his livelihood. If more amateur bee-keepers followed the professionals in choice of apparatus and methods of management, more of them could develop their hobby into a profitable side-line or even a means of livelihood.

Everything written by Mr. Manley makes good reading and is worthy of careful study. It is only on re-reading this work, now ten years old, that one realizes how far the first edition was in advance of the teaching of that time. Many bee-keepers have yet much leeway to make up. Some of them know it and will welcome this re-issue.

One could wish that the author could have found time to re-write some few parts of the work, for he surely has something to teach us on hive ventilation; treatment of disease also would be brought up to date.

Mr. Manley is perhaps the only writer who gives really reliable and detailed information on the costs and profits of commercial bee-keeping. This information is all on a pre-war basis, but as figures were then at least stable the reader can make his own corrections, whereas comparison at a later date with 1946 figures would be by no means simple.

E. B. WEDMORE

History of Air Navigation

By Arthur J. Hughes. Pp. 154. (London: George Allen and Unwin, Ltd., 1946.) 10*s*. 6*d*. net.

ALTHOUGH published in 1946, it appears from the preface that this book was completed in 1944. It was not possible, therefore, to give any information about war-time developments to aid air navigation, of which particulars at that time had not been released. The book was thus out of date before it was published. It is disappointing in other ways; illustrations of a great variety of instruments are given, but in many cases without sufficient description for those who are not familiar with them to understand how they are used. The reader will look in vain for any account of special methods of navigation adopted for polar flights. The chapter on ancient navigation has nothing to do with air navigation. Although aviation has a short history, developments—stimulated as they have been by two great wars—have been rapid. A fascinating story of the history of air navigation might have been written. This book seems to fall between two stools: it is not sufficiently technical and specialized for the expert, but it is too technical and assumes too much basic knowledge for the general reader.

Digestion

Edited by H. J. Vonk, J. J. Mansour-Bek and E. J. Slijper. Part 1. (Tabulæ Biologicæ, Vol. 21.) Pp. xvi+284. (Amsterdam: Dr. W. Junk, 1946.)

THE editors explain in the preface that the manuscripts of this volume were ready in 1939, but the difficulties caused by the War and the German occupation of the Netherlands delayed printing until this year. The whole volume is now to be published in three parts, the first two dealing with vertebrates and the third with invertebrates, of which this is the first. An appendix, containing the accumulated data of the last seven years, is planned and will be included in the third part.

The present part contains articles on the physiological anatomy of the digestive organs and on the food of vertebrates, on the rhythmic action of the glands of secretion and their composition, and on the digestive enzymes. With one exception (an article by Linderström-Lang and Holter on the distribution of enzymes in the mucous membrane of the gastro-intestinal canal) the authors are all Dutch. We may notice particularly the article on the digestive enzymes by Chr. Engel, which is a valuable summary of the knowledge up to 1939. However, in view of the great progress made in recent years on the pancreatic enzymes, there is no doubt that much of the older work on the peptidases, etc., of the intestinal canal will need re-evaluation.

J. A. V. BUTLER

Experimental Plastics and Synthetic Resins

By Dr. G. F. D'Alelio. Pp. ix+185. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1946.) 3 dollars.

THIS publication should prove of considerable value to graduate students starting upon a career in the plastics industry. We have nothing quite like it in Great Britain. Ninety-seven experiments are described and twenty-seven test methods. A distinctive character of the book is the way in which these exercises are put together; they all need thought rather than mere routine attention. Among the tests are such interesting topics as the determination of *p*H, acid number, and degree of unsaturation (akin to the iodine number). In the arts and crafts there should be a future for this compilation, since the use of methacrylate esters and the various polyvinyls is increasing in these fields. It would be advantageous if museum and gallery workshops could be provided with this book, for their skilled technicians to see what can be done with polymers and condensation products in general.

The attractive format and neat arrangement of the text are commendable.

F. IAN G. RAWLINS

The Gas-filled Triode

By G. Windred. Pp. 72. (London: Hulton Press, Ltd., 1946.) 2*s*. 6*d*. net.

THIS monograph outlines both the historical and practical aspects of the gas-filled triode; these devices find many applications in industrial control and trigger circuits. The author gives a complete list of those models available at the present time, together with their operating conditions and possible circuits.

Systematic Inorganic Chemistry of the Fifth-and-Sixth-Group Non-metallic Elements

By Prof. Don M. Yost and Horace Russell, Jr. (Prentice-Hall Chemistry Series.) Pp. xx+423. (London: Oxford University Press, 1946.) 21*s*. net.

THIS book was published in the United States in 1944, and was reviewed in *Nature* (154, 723; 1944). The present issue has a new title-page, but is otherwise the same. The book is one which can be recommended to students, and the fact that it has been made available in Britain is to be welcomed.

ADVANCED INSTRUCTION IN PRACTICAL MATHEMATICS*

By A. ERDÉLYI and JOHN TODD

ALL who watched the development of industrial research in recent decades and those who, during the War, had an opportunity of observing work in Government research departments, must realize that the usual academic syllabus in mathematics does not provide an adequate preparation for a future research worker in Government service or industry. Students, for example, of engineering (with which we include, for the sake of brevity in this article, physics, chemistry, etc.), biology or economics, do not get, as a rule, a mathematical training sufficiently advanced to enable them to follow up, and participate in, recent research in their subjects; and the training of students of mathematics is not very suitable for the type of work we have in mind. The truth is that in recent decades there has grown up a new type of research worker—Dr. N. W. McLachlan has called him the mathematical technologist—and so far British universities have not provided very much for him. An urgent need thus arises for an institution where students are instructed in advanced mathematical techniques not usually included in university curricula, yet needed in 'mathematical technology' (and mathematical biology or economics for that matter) and where they are introduced to research. The need for such an institution, which we may call an 'Institute for Practical Mathematics', was pointed out in a recent article[1] which, evaluating the war-time experience of the Admiralty Computing Service, came to the conclusion that such an institution is necessary both to teach potential 'customers' of the industrial mathematician to state their problems in a suitable way, and also to ensure that the mathematician will be able to tackle these problems in a practical manner.

Since it is impracticable to add to the present syllabus without dangerously lowering the standard of instruction, and since there is scarcely anything in that syllabus that could profitably be discarded in order to make place for more practical mathematics, it is inevitable that the main activity of the suggested institute should consist of post-graduate courses. This theoretical conclusion is borne out by practice in the United States, where such post-graduate courses have been given, for example, at Brown and New York† Universities, for several years and have proved a great success. There is much to be learned from the American courses, notably the beneficial effects of a close collaboration between the academic institutions on one side, and Government agencies and industry on the other side. It is perhaps not too much to say that the usefulness of such courses depends in the first place on the success with which this collaboration is maintained. The role of industry and Government departments is a threefold one; they suggest suitable subjects of instruction, send students, and also provide some of the instructors. In this way a very fruitful and mutually beneficial contact is established between the academic and the industrial mathematician.

* This article is published with the permission of the Director of Physical Research, Royal Naval Scientific Service

† It is regretted that, in the article in *Nature* of May 4, New York University was confused with another place. Notes of lecture courses at both Brown University and New York University were made available in mimeographed form; some have now been published as books. These give some idea of the level of instruction necessary.

Among the principal functions of the suggested Institute for Practical Mathematics we may mention short courses for engineers and others; advanced courses for mathematicians; research; and the preparation of monographs

Engineers, biologists, economists, and other potential 'customers' of the practical mathematician should be given instruction in routine techniques In addition, they ought to attend courses of a broader character in which they would get a general idea of methods of modern practical mathematics without learning any details, see what types of problems are accessible to mathematical treatment, and learn to formulate their problems in a suitable way. Engineers lacking such training have been known to give up a problem as a 'bad job' because it did not seem to be amenable to the mathematical methods with which they were familiar: yet, had they only known it, there was an efficient method of dealing with the problem, a method, though, which requires a specialist and is outside the reach of a general practitioner of applied mathematics. Still worse, in some cases the engineer 'over-simplifies' his problem in order to make it accessible to what he considers the appropriate technique and thereby makes the work more cumbersome, if more elementary, and the result of less practical value. The purpose of the mathematical training of an engineer (and on a higher level that of a practical mathematician) should not be to provide him with the detailed working knowledge of as much of mathematical technique as possible within a given limit of time; the aim should be to give him a detailed working knowledge of the most frequently used routine techniques, together with a comprehensive survey of what a mathematician can do for him, and also to teach him how to collaborate with the mathematician when occasion demands it.

The reader may feel that we labour this point unduly, but it is in fact an important one: to explain what we mean an example given in the earlier article may be mentioned. Every engineer should be able to perform elementary numerical work, interpolation in tables, numerical solution of equations, numerical integration, etc.; but to attempt to teach much more in a short course is not worth while: numerical work involving advanced techniques or large-scale computations (systematic tabulation) should be left to the professional computer. Yet, the engineer should have a sound idea of what the modern computer can do for him. Instead of teaching the engineer yet a few more numerical methods which in any event he would not have to use often, and not be able to use efficiently, he should be given a comprehensive survey of modern numerical methods, including machine computations and specialized computing equipment such as differential analysers and punched-card equipment.

Post-graduate courses for mathematicians should be the backbone of an Institute for Practical Mathematics. A general mathematical background of about the standard of B.A. or B.Sc. honours degree would be assumed and students should be offered degree courses for M.A and M.Sc. degrees and also facilities for research leading to a Ph.D. degree. Here again detailed instruction should be given in a number of subjects, and the student allowed selection in a wide range of courses offered (a biological mathematician would naturally make a selection different from that of a research worker in electromagnetic theory): and the specialized courses should be supplemented by a general survey of as nearly as possible the whole of practical mathematics. Besides full courses, there should be single lectures or short courses on selected topics. The courses, on the whole, should be much more concerned with the mathematical techniques than with technicalities in the domains of their applications; but some instruction in the latter fields must be contemplated, for in many cases it is neither possible nor desirable to teach the techniques completely independently of their background. To make this point clear, we can imagine a student, becoming interested, say, in elasticity, in his undergraduate days, and coming to the Institute to learn some of the newer mathematical tricks and to see them applied to *old* problems, and then returning to his teacher to apply them to *new* problems

We mention here some of the subjects which in our opinion should be taught, it being understood that the list is neither exhaustive nor definitive, nor are the subjects arranged in order of importance: it merely serves to indicate the general trend as we have observed it.

Interpolation, numerical differentiation and integration least squares, curve fitting, difference equations;
Advanced numerical and graphical methods (including relaxation technique and machine methods of computation),
Slowly convergent series (transformations by means of contour integrals convergence factors, Euler and other transformations),
Matrices and tensors (with applications to engineering problems);
Conformal mappings and two-dimensional potentials;
Contour integration (with practical applications);
Asymptotic series;
Laplace and Fourier transforms (Heaviside operational calculus);
Special functions (Bessel, Legendre and other functions, orthogonal polynomials),
Boundary value problems (separation of variables, general solutions, solution by means of functional transformations),
Non-linear differential equations (oscillations);
Integral equations (including the non-linear integral equations of oscillation theory and biology),
Calculus of variations (including the Rayleigh–Ritz method and other approximations),
Electromagnetic and acoustic waves
Mathematical theory of elasticity (plates and shells),
Stability problems (buckling),
Hydro- and aero-dynamics (including shock waves, supersonic motion and turbulent flow),
Mathematical theory of servo-mechanisms,
Thermodynamics;
Theory of games (for economical applications),
Algebra (for biologists),
Elements of mathematical statistics (errors, various standard distributions, etc),
Probability theory and its applications to the testing of statistical hypotheses and statistical estimating (for example, design of experiments and production control),
Random processes and time series

At a later stage such an institution, with a nucleus of permanent staff, a fluctuating body of temporary and part-time instructors, and research students, could develop into a natural centre of research in practical mathematics. Fundamental research in this branch of mathematics would prosper in an atmosphere in which an intimate contact with the needs of industrial research associations is combined with academic mentality. Industrial research institutions on encountering a problem which needs a new mathematical technique would not unnaturally send some of their staff to the Institute of Practical Mathematics to learn that technique, and in many cases also to carry out some of the research under expert supervision there.

To facilitate research, and to make its results available to wider circles, it is desirable to publish monographs on subjects on which the current literature does not provide adequate, or adequately arranged, information. The Admiralty Computing Service in Great Britain, and similar organisations abroad*, have done great service in issuing such monographs as a "Catalogue of Conformal Representations", a "Manual of Non-linear Oscillations". In these monographs, results scattered in periodicals and text-books are collected and arranged so as to be of the greatest possible practical value. A body in which teaching and industrial research experience join hands would clearly be the most suitable centre for the publication of such monographs: it would be able to ensure a high scientific level and at the same time the greatest possible practical usefulness both in the selection of the material and in its presentation. As a large project of this character which deserves attention, we mention a manual of the solutions of the partial differential equation of wave motion. The efficient carrying out of such a project would depend on team-work in which academic and industrial research workers would collaborate, and the Institute for Practical Mathematics would be the natural place for this collaboration.

As to the location of the Institute, the strong concentration of industrial and Government research establishments makes it natural for it to be situated in or near London, where these research establishments and the University of London with its many colleges provide a considerable reservoir of potential part-time students and part-time teachers. There has been for some time at the Imperial College of Science and Technology[2] a strong tendency towards instruction in practical mathematics, and more recently the University of London has realized the need for courses in "Ancillary Mathematics" for students of various sciences, and such courses are now being given at some colleges. This instruction has, however, been mainly at undergraduate level, and, most desirable as it is, cannot in general lead directly to productive research. However, the experience of those concerned with these courses will be invaluable in any planning of post-graduate courses. For reasons such as these the Institute for Practical Mathematics might most conveniently be organised as a School or Institute of the University of London.

We hold that the Institute for Practical Mathematics should have a comparatively small permanent full-time staff, augmented by part-time staff and temporary full-time staff. The part-time staff could be drawn mainly from the London colleges and from research establishments in or near London; the temporary full-time staff would consist of visiting lecturers from abroad, from provincial universities and technical colleges, and industrial research workers spending their sabbatical year (or other kind of long leave) at the Institute. Thus a steady general trend could be combined with great flexibility and variety.

The majority of the students would be full-time students taking a post-graduate course immediately after taking their first degree. These students would be those who have shown a definite interest in research involving practical mathematics, or those who have been advised to consider a career in directed research rather than one in fundamental research.

* It is hoped that arrangements will shortly be made for the full publication of those monographs which have so far been available only to Government departments and similar agencies. Among the books of this character published outside Great Britain which have come to our notice are

Kamke, E., "Differentialgleichungen. Losungsmethoden und Losungen", 1 and 2. (Leipzig, 1943, 1944)
Magnus, W., and Oberhettinger, F, "Formeln und Sätze für die speziellen Funktionen der mathematischen Physik" (Berlin, 1943).
Ryzhik, I. M., "Tables of Integrals, Series, Sums and Products". (In Russian.) (Leningrad, 1943)

After completing their courses these students would be ready for posts in Government or industrial research or for teaching posts, especially in the new technical colleges. Among the other students would be found some part-time ones specializing in their last (undergraduate) year. In addition, there would be research workers from Government or industrial establishments who would be attending courses or carrying out research, some full-time, some part-time.

It is believed that an institute planned on these lines would soon justify its existence by its usefulness: it would satisfy an urgent recognized need and therefore no very great difficulties are anticipated in financing it. It is difficult to estimate the size of such an institute at the time when higher education in Great Britain will have settled down to a steady state. It is, however, clear that there is a fairly definite size below which it would not be efficient, in so far as that it could not provide satisfactorily comprehensive courses. There is no doubt that there would be enough work, in each of the suggested directions, to occupy fully an organisation of the minimum size from the very beginning, and staff could be added and its scope extended in various directions in the light of experience. For example, there is a need for a British journal on the lines of the German *Zeitschrift fur angewandte Mathematik und Mechanik* or the new American *Quarterly of Applied Mathematics*, and this institute would be the natural editorial centre.

[1] Sadler, D. H., and Todd, John, *Nature*, **157**, 571 (May 4, 1946).
[2] See, for example, Chapman, S., "University Training of Mathematicians", *Math Gaz.*, **30**, 61 (1946).

PRINCETON UNIVERSITY, 1746–1946

By PROF. HUGH S. TAYLOR, F.R.S.

PRINCETON UNIVERSITY in Princeton, New Jersey, one of the five older institutions for higher learning in the United States, is celebrating the two hundredth anniversary of the granting of the original charter from King George II of England to the College of New Jersey on October 22, 1746. In deciding, in spite of many difficulties now confronting all institutions of higher learning in America, to organise a celebration of the event, the University based its decision on the belief that, in the present critical condition of the world, a re-dedication to the ideals of freedom and of obligation to the nation and to the world which have for two centuries animated the life of the University could not be ignored. Princeton, therefore, proposed "to direct its Bicentennial Celebration to the end of applying, in consultation with scholars throughout the world, our common skills, knowledge, and wisdom to the reconsideration of the fundamental obligations of higher learning to human society, hoping thus to contribute to the advancement of the comity of all nations and to the building of a free and peaceful world".

The primary means of implementing this purpose was the organisation of a series of fifteen scholars' conferences extending throughout the academic year 1946–47. These conferences are restricted in size and limited to distinguished scholars from many nations. They reduce to a minimum the presenting of formal papers, and develop to a maximum a free interchange of ideas among the members who meet as equals. Taken in their ensemble, they represent the first world congress of scholars of the post-war era

The first six of these conferences have been completed. They form a progression from "The Future of Physical Science" through "The Chemistry and Physiology of Growth", "Engineering and Human Affairs", "The Evolution of Social Institutions in America", "The Development of International Society" to "The Humanistic Tradition in the Century Ahead", a progression from the physical and natural sciences through the social sciences to the values of humanism in the critical years ahead. Thirty-five foreign scholars representing fifteen other nations have joined with American scholars in three-day conferences on each of these six topics. In one conference eleven Nobel prize winners participated. The members of another conference were authors of more than a thousand books.

The remaining nine conferences of the second series, which will take place between the middle of November and May 1947, include two on the university—one on its relation to the public service, and one other relating to its world responsibilities. There will be one conference on the problems of mathematics, one on genetics, palæontology and evolution, one on the Near East and one on the Far East. There will be two on the fine arts, one restricted to the field of research and scholarship in the arts, and the other pertaining rather to the social implications of the fine arts in relation to the planning of man's physical environment. The final conference of this series in May will deal with secondary school education in the United States. The presence of so many noted world scholars in Princeton to attend the conferences in the course of the year has permitted the securing of an unusually distinguished list of bicentennial lecturers. The series of lectures already begun will be continued throughout the year. Bicentennial concerts and exhibitions in the realm of art form a part of the programme, especially with reference to the conference on "Research and Scholarship in the Arts" to be held late in April 1947.

Two convocations have already been held in September and October, and two more are to be held in February and June. At the first, the Archbishop of Canterbury, who preached the inaugural Bicentennial Sermon, the first of a series of ten, received an honorary degree. At the second convocation, concluding the first series of conferences, twenty-three honorary degrees were conferred. Eight scholars from Britain, including Lord Lindsay of Berker, Sir Hector Hetherington, Sir Harold Hartley, Sir John Boyd Orr, Sir Henry Hallett Dale, Salvador de Madariaga, Michael Polanyi and Ernest Woodward, were among the recipients of these degrees. For the final ceremonies and the convocation on June 16, 1947, delegates from colleges, universities and learned societies of the world will be invited to attend.

The bicentennial publication programme contemplates the issuing of twelve or fifteen books on various subjects, largely those dealing with the history of the university. In addition to this there will be published for each of the fifteen conferences a thirty-six page pamphlet summarizing the conference and giving its programme and list of members. The further question of what books may emerge from these conferences is one which is being studied conference by conference as the programme proceeds.

A series of events has been arranged for February 22, 1947, which is Washington's birthday and, normally, Alumni Day in Princeton. The University on this occasion will honour especially distinguished scholars from among its own alumni at the convocation then planned. The June ceremonies will cover a period of about five days, beginning with the 'commencement' on June 13 and ending with the final convocation on June 17. The first three days of this period will be devoted to events of particular interest to the alumni. Plans are being made for a historical spectacle to be enacted in the Princeton stadium on June 15. The events of the programmes of June 16 and 17 will be of particular interest to the delegates, of whom it is expected there will be approximately eight hundred. During this June period there will take place the dedication of the new gymnasium, the laying of the corner-stone o the great new library, a formal dinner for distinguished guests and delegates at which the President of the United States and others will speak, and the awarding of honorary degrees at the final convocation.

What really distinguishes this particular programme from similar celebrations in the past is, in the first place, the fact that it is taking place in the period of an entire academic year. This permits the manifold activities to take place at a more leisurely tempo, in which each has its own place and right to existence without the competition of other concurrent events. In the second place, and far more important, it differs in that although at times of anniversaries such as this there is much justification for a historical point of view and for dwelling upon past achievements, the entire orientation of this programme is forward-looking. To be sure, we are not forgetting Princeton's long and honourable history, which will receive adequate attention in the course of the programme. We are, however, far more interested in the idea that, given proper orientation at this time, the efforts of the world of learning may prove as potent an instrument for good in a peaceful post-war world as they were potent for destruction during the period of the War.

JUBILEE OF THE BRITISH MYCOLOGICAL SOCIETY

By G. C. AINSWORTH

THIS year, the British Mycological Society, which was founded at a meeting of the Yorkshire Naturalists' Union at Selby in 1896 for "the study of mycology in all its branches", has been celebrating its jubilee. At an ordinary meeting on April 12 a comprehensive series of exhibits was arranged in the British Museum (Natural History) to illustrate the development of mycology in Great Britain and the history of the Society. In September, a well-attended five-day foray, held at Whitby in conjunction with the Mycological Committee of the Yorkshire Naturalists' Union, marked the resumption of a series of annual autumn forays begun in 1897 which, though uninterrupted by the First World War, had to be discontinued in 1939. The climax of the celebrations was the fiftieth annual general meeting, followed by the presidential address and five paper-reading sessions in the rooms of the Royal Institution, London, during October 23–25. This meeting, by the generous help of the British Council, was attended by mycologists from Austria, Belgium, Czechoslovakia, Denmark, France, Greece, Palestine, Switzerland, Sweden, and the United States.

In reply to an expression of loyal greetings from the annual meeting, a message of appreciation was received from H.M. the King. Greetings were received from foreign mycological societies (including an illuminated address from the Society for the Advancement of Mycology in Denmark) and from British natural history societies, while numerous members unable to be present sent messages of good will. In addition, the president received a letter of good wishes from Mr. Herbert Morrison, Lord President of the Council.

After the officers of 1947 had been elected as follows: *president*, Prof. C. G. C. Chesters; *vice-president*, Dr. J. T. Duncan; *secretary*, Dr. G. C. Ainsworth; *foray secretary*, Mr. G. Smith; *treasurer*, Mr. W. Buddin; *editors*, Dr. B. Barnes and Mr. W. C. Moore; the following honorary members were elected: Dr. B. O. Dodge (New York Botanical Garden), Prof. R. Falk (Palestine), Prof. Ernst Gaumann (Zurich), Prof. Roger Heim (Paris Natural History Museum), and Mr. A. A. Pearson, who has been treasurer of the Society for twenty-eight years.

Thirty-seven new applications for membership were approved. The membership now stands at 430—the highest in the Society's history.

The president, Dr. J. Ramsbottom, in an address entitled "Mycology then and now", traced the beginnings of the Society and outlined the course of mycology, and particularly the study of the subject in Great Britain, during the past hundred and fifty years. With characteristic flashes of humour he surveyed the successive fashions in mycological research, suggested directions for future efforts, and welcomed the increasing recognition that was being accorded to the one-time 'Cinderella of botany'.

The papers read at the subsequent sessions were designed to illustrate the relation of mycology to allied subjects, and they are to be published in full, together with the presidential address, in a special volume of the Society's *Transactions*. At the first session, which was devoted to mycology and medicine, Dr. C. W. Emmons (U.S. Public Health Service) reviewed fungi as a cause of disease in man, and Dr. J. H. Birkinshaw (London School of Hygiene and Tropical Medicine) gave an account of fungal metabolism with particular reference to the production of antibiotics active against organisms pathogenic to man. Dr. Emmons attributed the relative neglect of medical mycology in part to the great impetus given to bacteriology by Pasteur, Lister, and Koch, and to the fact that bacterial diseases of man are more common than those caused by fungi. He directed attention to the fact that although in the United States fungi were only held responsible for 0·03 per cent of the total deaths in 1942, this percentage was nearly twice that of the deaths attributed to paratyphoid fever, smallpox, cholera, and half a dozen other well-known diseases taken together. He pointed out that effective prophylactic or control measures are available to reduce the number of fatalities due to these better-known diseases, but to set against this, mycoses such as ringworm and other skin infections are not fatal diseases, although common and annoying. It is also possible that there are not infrequently mild forms of the generalized fungus infections which are not always correctly diagnosed. Coccidioidal granuloma, for example, was first recognized in California in 1894, where it was considered to be invariably fatal; but it was not until 1937 that 'valley fever' or 'desert rheumatism' was recognized as being a mild, very frequent form of the same disease; perhaps only once in 5,000 cases does the mild form develop into the fatal disease. Against such a background an illustrated account was given of the mycological peculiarities of fungi of medical importance, and attention was directed to a number of unsolved problems involving the natural habitats and transmission of these fungi and the treatment of the diseases they cause.

After indicating earlier milestones in studies in the metabolism of moulds, Dr. Birkinshaw briefly described the method of approach to this subject developed by Prof. H. Raistrick and his school, and indicated the type of result obtained. In the course of a survey of selected groups of chemically related fungal products he traced the history of penicillin—the discoverer of which, Sir Alexander Fleming, was in the chair—noted the promising nature of streptomycin and indicated the chemical structure of these and other antibiotics, and discussed the prospects of the discovery of new and better antibiotics in the future.

Introducing the Thursday morning session, Mr. W. C. Moore (Ministry of Agriculture's Plant Pathology Laboratory) claimed that until recently the study of plant diseases in Britain had been dominated by investigations on plant pathogenic fungi. He directed attention to the misuse of the term 'mycologist' in the sense 'plant pathologist', and noted that the erstwhile advisory mycologists have become the advisory plant pathologists of the new National Agricultural Advisory Service. Mycologists and plant pathologists have a common interest in so far as they are concerned with plant pathogenic fungi, and such a common interest is well illustrated by the topic of seed-borne fungous diseases which was introduced by Dr. Lucie C. Doyer (Seed Testing Station, Wageningen), who gave a comprehensive account, illustrated by lantern slides, of different types of seed-borne fungi and the methods for their detection. Dr. Doyer particularly emphasized the wider aspects of the subject and indicated the urgent need for international co-operation in matters of seed testing, to facilitate the movement of seed from one part of the world to another. Attention was directed to the International Seed Testing Association, at the next congress of which (to be held in the United States) international rules for the determination of seed-borne diseases will be discussed, and on the committee for the determination of plant diseases of which fourteen countries are represented. Prof. A. E. Muskett (Queen's University, Belfast) then described the techniques developed in Northern Ireland for examining seed for seed-borne diseases with special reference to *Helminthosporium* disease of oats, the seed-borne diseases of flax, and blind seed disease (*Phialea temulenta*) of rye-grass. Prof. Muskett indicated certain results of a survey of flax seed produced in the United Kingdom during the past three years. Contamination by *Colletotrichum lini*, *Polyspora lini*, and *Phoma* sp. was much heavier north and west of the Pennines than south and east. The purity and germination of contaminated samples were of a very high order, and such samples would be legally acceptable as seed of first quality. It is, however, the build-up of parasites by repeated sowings of seed from the same stocks that is responsible for the failure to produce flax seed under the climatic conditions which prevail in the north and west. Dr. Mary Noble (Seed-testing Station, Edinburgh) communicated a paper on a seed-borne disease of clover, particularly of New Zealand seed, caused by previously undescribed species of *Sclerotinia* the *Botrytis* state of which bears a superficial resemblance to *B. anthophila*.

The afternoon topic illustrated the relation of soil fungi to forestry and soil fertility. Prof. Elias Melin (University of Uppsala) read a paper on recent advances in the study of tree mycorrhiza, summarizing researches made by himself and his pupils and by other workers in this field. He emphasized the importance of Basidiomycetes among mycorrhiza-forming fungi, and showed lantern slides of a representative series, directing attention to the fact that many species of fungi, not always nearly related to one another, may form mycorrhiza with one and the same species of tree. For example, about thirty species have so far been proved able to form mycorrhizal associations with the Scots pine (*Pinus sylvestris*). He then described certain physiological requirements of mycorrhizal fungi and touched on the water-soluble, thermo-labile substances demonstrated in leaf litter, and able to exercise a strong antibiotic action against tree mycorrhiza fungi[1]. Prof. C. G. C. Chesters described ingenious methods for sampling the fungi of the soil, by which fungi ramifying through the soil can be distinguished from those confined within different types of plant debris, and he indicated the preliminary results of surveys using such techniques. The session ended with a showing of the beautiful, if somewhat sinister, film of high technical merit made by Dr. J. Comandon and Mr. P. de Fonbrune (Pasteur Institute) of various nematode-catching fungi belonging to the Zoopagaceæ. The details of the mechanisms by which these fungi secure their prey was clearly demonstrated by skilful micromanipulation.

On Friday morning, with Prof. W. Brown in the chair, Dr. Nils Fries (University of Uppsala) gave a lucid summary of the nutrition of fungi from the aspect of growth-factor requirements. After dealing with the growth-factors so far recognized, he gave an account of our present knowledge of the part they play in fungal metabolism, and in conclusion indicated the results he was obtaining by a new technique for isolating physiological mutants. Using this method the author had obtained more than five hundred mutants of *Ophiostoma multiannulatum* during the last three months, and four hundred of these had already been roughly classified in respect of their growth-factor requirements. Dr. Lilian Hawker (University of Bristol) then illustrated the subject by a particular example, summarizing the results of researches carried out over a period of years on the effect of growth substances on the mycelial growth and fruiting of *Melanospora destruens*.

At the final session taxonomic problems were discussed. Dr. M. A. Brett described recent observations on *Cladosporium herbarum*, Miss E. M. Wakefield (Royal Botanic Gardens, Kew) discussed the criteria for the delimitation of species and larger groups in the Hymenomycetes, and Prof. Roger Heim dealt with problems of taxonomy and phylogeny in macro-fungi with special reference to a number of forms showing gill-like pores or pore-like gills, recently described by him from tropical Africa.

In addition to the London meeting there was an excursion for foreign guests and members on the previous Sunday to Kew Gardens and Hampton Court, a foray to Windsor Forest on the Tuesday, and a series of informal evening meetings at which Dr. P. H. Gregory introduced a slow-motion film made by Mr. E. D. Eyles showing the part played by raindrops in effecting spore dispersal in *Lycoperdon perlatum*. Dr. E. J. H. Corner exhibited a very beautiful series of drawings for a monograph on *Clavaria* (executed by the author while interned by the Japanese in Singapore), and Dr. W. A. R. Dillon Weston arranged a series of his glass models of fungi.

The one shadow over the celebrations was the death in July at the age of eighty-five of Carleton Rea. Mr. Rea, a barrister by profession, was the author of "British Basidiomyceteæ" (1922), and had an international reputation as a student of the larger fungi. He was one of the founders of the Society, of which he was secretary from its inception until 1918, treasurer during 1897–1918, an editor of the *Transactions* for thirty-four years, twice president, and a vice-president for 1946.

[1] Melin and Wiken, *Nature*, 158, 200 (1946)

THE KING'S PICTURES

By Dr. A. T. HOPWOOD
British Museum (Natural History)

DURING the interval between the two World Wars, the Royal Academy added to its fame by a series of winter exhibitions unsurpassed in the history of art. The Italian, Dutch, and other Exhibitions are still fresh in the minds of those who visited them. Now that fighting has again ceased, the president and members are able, through the gracious kindness of His Majesty the King, to celebrate the return of more peaceful conditions with an exhibition in every way worthy of its great predecessors.

Some of the five hundred pictures are always accessible to the public at Hampton Court, and others at Windsor. Still others have been exhibited from time to time, or else are known from reproductions; but this is the first time that the cream of the Royal Collections has been gathered together in a series of rooms designed for the sole purpose of showing pictures. The result is a display which for richness and variety could scarcely be equalled anywhere else in the world. Eight Rembrandts, five Holbeins, a Vermeer, a Duccio, three Titians, seven Tintorettos, a whole room full of Primitives, three rooms devoted to Italian pictures, with another for Canaletto, two rooms for the Dutch School and one for the Flemish, add to these five rooms of portraits and one of English subject pictures, and there in brief is what the Exhibition contains.

With so much to see, one is bound to be influenced by personal taste; I found greatest pleasure in the early portraits (Gallery I), the Primitives (Gallery IV) and the Flemish and Dutch Schools (Galleries VIII, IX, X); but apart from purely artistic matters, there are other aspects of the Exhibition worthy of consideration.

In portraiture, for example, it is interesting to compare the changes in fashion and taste both in artists and sitters; to compare the subtle flattery of Van Dyck with the frankness of the portrait of the Emperor Charles V (No. 142), attributed to the studio of Bernaert van Orley, and the almost equally frank pastels by J. E. Liotard (No. 74); or the grand manner of previous reigns, with the domestic felicity of the early years of Queen Victoria.

Another point arises from the consideration of three works by Lucas Cranach the Elder (Nos. 139, 140, 153) and one by his younger son, Lucas Cranach the Younger (No. 148); all four pictures are, to quote the catalogue, "signed with the snake". The father ran a successful workshop, or factory, in which his sons Hans and Lucas were employed; the snake was the trademark. Greater men than Cranach had their workshops, whence they issued as many pictures as they could sell. Most of the task of painting was left to apprentices and pupils who followed a given design. The master usually, but by no means always, painted the flesh. Holbein may have had such a workshop (*cf.* note to No. 6), but his studio and records perished in the fire which destroyed the Palace of Whitehall. Rubens certainly did; his most brilliant pupil and assistant was Van Dyck. A *modello*, or pattern, from Rubens' studio is in the present Exhibition (No. 279). Tintoretto (No. 206) also employed assistants. Indeed, the practice was widespread, and, however shocking it may appear to a later generation, it was sound common-sense to those who followed it. Not only did those who lived by the brush give their patrons what they wanted, but also they saw to it that their wares were available in sufficient quantity.

A study of Charles I on horseback by Van Dyck (No. 32) is of interest in connexion with a picture by Vrancx (No. 278) and an equestrian portrait by Rubens (No. 287). Van Dyck has given his horse a head which appears small in proportion to the body. This is a feature generally seen in pictures of the seventeenth and early eighteenth centuries. It is usually considered to be a convention without foundation in fact, but this view does not commend itself for a variety of reasons. First, it was during the seventeenth century that the influence of the Arab cross was beginning to be felt, and although the man at arms continued to be mounted on the Great Horse, as in Vrancx's picture, nobles and princes were riding more mettlesome steeds possessing a mixture of the hot blood and the cold. The proportion of the length of head to the body is approximately the same in the Great Horse and the Arab, but when the breeds are crossed the Arab head appears on the larger body. Secondly, horses of these proportions were fashionable during the Baroque period, and were described in the works of such contemporary masters of horsemanship as the Duke of Newcastle ("A New Method . . .", London, 1667), La Guerinière ("École de Cavallerie", Paris, 1729) and Winter ("Stuterey", Nuremberg, 1687). La Guerinière's illustrations are by various engravers after drawings by C. Parrocel, some of whose preliminary sketches are in the Royal Library at Windsor. It is significant that in these studies, too, the horses have the same small head.

Such parade horses, trained in the *Haute École*, were valued on the Continent for their length of mane and tail, but the horse shown in Rubens' picture is only a moderate example. It in no wise compares with the animal presented to the Landgrave of Hesse-Cassel by the Count of Oldenburg. Winter says that the mane and tail were protected by bags of red velvet, otherwise one groom was needed to carry part of the mane, and two others to carry the tail.

There are many other side-lines which might be discussed, but, when all is said and done, they remain side-lines subsidiary to the over-riding interest of the pictures as pictures ; although some knowledge of them is often a help in coming to a proper understanding of the pictures themselves.

Lastly, a word of praise must be given to the Catalogue. In it are a brief history of the Royal Collections, biographical notes on the artists, and references to literature on which the student may draw for additional information. It will retain its value as a handy work of reference long after the Exhibition has ended.

THE SOCIAL SURVEY

By Prof. P. SARGANT FLORENCE
University of Birmingham

THE phrase 'social survey' now covers a multitude of activities, which differ in aim and method. The aim of the earliest English surveys, such as Booth's "Life and Labour of the People of London" and Rowntree's "Poverty", were to discover in specific areas the extent and degrees of poverty in the sense of family income low in relation to the expenditure on food and other necessities. The aims of more recent social surveys, such as the Worcester Civic Survey[1] or the Herefordshire Survey[2], have been to lay a foundation for physical planning, and the location of industry ; or, like the work of the War-time Social Survey, to obtain information for solving immediate *ad hoc* problems of fact and opinion confronting Government departments.

There can be little doubt of the usefulness of surveys to achieve many of these aims. In a paper to the Institute of Public Administration, Mr. Louis Moss mentions war-time surveys carried out to determine fair clothes rationing where work entailed extra wear and tear, and fair fat and sugar distribution between bakers and cake-making housewives. He adumbrates future surveys into the kinds of houses that will satisfy both human needs and technical possibilities, and into the obstacles in the way of full utilization of man-power. The planning surveys include among their aims the greater accessibility of work-places, schools and shops, and therefore map the existing sites of all these places in any given area in relation to homes of the population. Their recommendations for industrial location help to solve problems of unstable and maldistributed employment.

The differing aims of surveys past and present have been achieved by methods that differ quite as widely, though a common factor is the standardized schedule of questions that are usually put. Controversy about the scientific validity of these methods has tended to fasten on the sampling technique employed, if any. But something more fundamental must first be discussed, and that is the nature of the original data. If the source of the data is liable to distort the facts, no amount of juggling with sampling formulæ will make results reliable.

Data are usually distinguished as documentary or as observed—observation being of environment, of behaviour, or of written or verbal responses. But documentary evidence must itself have been observed at one time. Figures of output, for example, enumerated in the Census of Production, are now documentary ; but originally they were observed by foremen, inspectors and managers in some factory, who duly recorded what they observed. A more fundamental distinction thus seems to lie between data observed by competent persons and checked and counterchecked (the usual process in official statistics), and data less certainly observed. It is a matter of degree how certain the observation is. On the whole, observation will be more certain under three types of proviso.

(1) Where observations of facts are direct by the surveyor and not gathered from other people's verbal or written statements. The statements of other people may distort facts owing to bias, emotion or failure to be observant ; or (if there is a time-lapse between fact and statement) by sheer failure of memory. This uncertainty does not apply where opinions and feelings are sought, or, at least, the *present* opinions and feelings of the persons making the statement.

(2) Where the observation of the surveyor can be checked by various tests, or several surveyors can be found to agree. Thus, in house-to-house visits there are a number of counter-checking tests of income and poverty ; and, more obviously, the sites or locations of homes, shops, factories, schools, etc., are there for all to see.

(3) This second proviso leads on to the further proviso that when people are asked for statements about facts they will be more accurate about recurrent and continuing facts than about passing events. Thus, a housewife can probably be trusted to be more correct about the number of rooms in her house, or the shops she frequents or the habitual place of work of her husband, than about past illnesses in her family or the precise nature of past purchases.

Social surveys of the type described by Mr. Moss have largely relied on verbal responses, and it is important to ask how far such data are likely to be sufficiently accurate for the type of knowledge required. They are probably not accurate enough for discovering past events ; though accurate enough for opinions, provided the questions are not so worded (and intoned) as to be leading questions. Mr. Moss is right to stress the importance to democratic processes of a continuous knowledge of public opinion.

Yet we hope that opinion surveys will not dictate policy. In the listener survey conducted by the B.B.C., classical music came very low indeed on the priority list of the majority of listeners. Similarly, simply designed furniture would probably come very low, compared to the ornate, in the scale of popularity. The B.B.C. wisely neglected to attune its programmes to debased popular taste ; let us hope a similar course will follow the surveys foreshadowed by Mr. Moss into the wishes and needs of consumers. English social surveys, if they are really to set the pattern of cultural life, will have to take a wider sweep and to integrate all phases of community and individual activity (whether reducible to statistics or not) as the anthropologist does when studying primitive societies. This application of anthropology has taken firm root in America, but we have yet to set about an English "Middletown"[3] or an equivalent to "Yankee City"[4].

[1] "County Town." By Glaisyer, Brennan, Ritchie and Florence. Department of Commerce, University of Birmingham. (John Murray.)

[2] "English County." By the West Midland Group on Post-War Reconstruction and Planning (Faber and Faber)

[3] "Middletown" and "Middletown in Transition". By R S. and H. M. Lynd. (Harcourt, Brace and Co.)

[4] "Yankee City." By W. L. Warner and P. S Lunt. (Oxford University Press.)

OBITUARIES

Prof. H. C. Plummer, F.R.S.

HENRY CROZIER PLUMMER, formerly professor of mathematics at the Military College of Science, Woolwich, and sometime Royal Astronomer of Ireland, died at Oxford on September 30, within a few weeks of his seventy-first birthday.

Born at Oxford on October 24, 1875, Plummer was brought up in a scientific atmosphere. His father, W. E. Plummer, was a first assistant at the University Observatory, Liverpool, then under the directorship of Pritchard, and afterwards director of the Observatory of the Mersey Docks and Harbour Board and reader in astronomy in the University of Liverpool. Plummer was educated at St. Edward's School, Oxford, and at Hertford College, where he distinguished himself by obtaining firsts in Mathematical Moderations and in Final Schools, and gaining the open mathematical scholarship; the study of physics claimed his attention for a further year. After a year as lecturer in mathematics at Manchester and another year as demonstrator at the Clarendon Laboratory, Plummer was appointed in 1901 assistant in the University Observatory, Oxford, then directed by H. H. Turner. A year's leave of absence at Lick Observatory in 1907 introduced him to spectroscopic work, which was then being rapidly developed at Lick and elsewhere in America. In 1912, Plummer left Oxford for Dunsink Observatory to succeed E. T. Whittaker as Royal Astronomer of Ireland and Andrews professor of astronomy in the University of Dublin. There his "Dynamical Astronomy" (1918) was written, a treatise that reveals Plummer's thorough grasp of the principles of celestial mechanics and a freshness and elegance of mathematical presentation that stamped the book as a notable contribution to the subject. His election to the Royal Society followed in 1920. Next year Plummer left Dunsink on his appointment to the professorship of mathematics at Woolwich, which he retained until his retirement in 1940.

Plummer's astronomical papers covered a very wide variety of subjects. Throughout his life he retained a lively interest in the theory of instruments; his last address to the Royal Astronomical Society in 1941 from the presidential chair was on the development of the vertical telescope—to which he had made contributions more than a third of a century before—and a critical sense of the degree of accuracy with which instruments must be credited. His clear geometrical insight enabled him to devise new theoretical methods—as in his application of projective geometry to the determination of binary star orbits—and to illuminate methods introduced by others; in this last connexion his paper on the mathematical principles underlying Schlesinger's method of 'dependences' may be mentioned as a fundamental contribution to this important method of photographic astronometry. Plummer was an expert on the 'theory of errors', and he wrote many papers on this subject, culminating in his "Probability and Frequency", published in 1939.

Plummer's interest in various problems of celestial mechanics was aroused in his early years and maintained throughout his life. The well-worn subjects of refraction and aberration found him with something fresh to say—he was one of the first to discuss the latter subject in the light of the principles of 'special relativity'. At Dunsink he had embarked on an ambitious programme on the photometry of variable stars, and he was the first, with Shapley, to throw out the suggestion that cepheid stars owed their variability to rhythmic pulsations. His work on the distribution of stars in globular clusters was remarkable for the analytical elegance which it displayed. These are but a few of his many activities in astronomical research. His acute historical sense must, however, not be forgotten, and especially his deep interest in Newton's manuscripts.

Plummer was president of the Royal Astronomical Society during 1939–41, an honour which he deeply appreciated. Quiet, modest and self-effacing, he was a staunch friend to those who had gained his confidence and esteem. In 1924 he married Beatrice Howard, daughter of the late H. H. Howard, who pre-deceased him by a few months.

W. M. SMART

Dr. J. J. Drbohlav

PROTOZOOLOGISTS generally, and other friends in Britain, the United States, and elsewhere, will learn with regret of the unexpected death on August 11 of Dr. J. J. Drbohlav at Prague, where he was head of the Department of Microbiological Diagnosis at the State Institute of Hygiene before the War.

Jaroslav Drbohlav was born at Úlibice, near Jičín (Bohemia), where his father was schoolmaster, on March 14, 1893. He matriculated at the University of Prague in 1912, and took his medical degree in 1917—during the First World War. While still a student he published several original papers (on respiration), and during the War acted as assistant in the Bacteriological Institute. Soon after the War he was made director of the pathological laboratory at Moravská Ostrava, where he successfully coped with an outbreak of smallpox. In 1921 he obtained a Rockefeller Foundation scholarship, and went to the United States to study in various bacteriological laboratories—especially at Harvard, where he took the doctorate in public health with a thesis on the relation of insect flagellates to leishmaniasis.

On his return to Prague, Drbohlav continued his studies at the State Institute of Hygiene, which he helped to found and where he was appointed chief of his department in 1929. Here he devoted himself to various problems of public health and microbiology, and published papers on many different subjects—the streptococci of puerperal fever, spirochætosis, tularæmia, malaria in Subcarpathian Russia, the extermination of rats, blood donors and blood preservation, etc. But after the German occupation of Czechoslovakia in 1938 he was forced to leave the State Institute and transferred to a minor administrative post, and finally retired prematurely in 1944. A patriotic Czech, he was lucky to escape with his life, as several of his colleagues were murdered.

Drbohlav published some hundred papers on his researches, mostly in the Czech language, but his international reputation rests chiefly on his joint publications with William C. Boeck (an American) during 1924–25 on the cultivation of *Entamœba histolytica*. This work—now a classic of protozoology—was done during his sojourn at Harvard. These two young men then succeeded for the first time in cultivating the parasite which causes amœbic dysentery in man, and introduced new methods which continue to bear ample fruit. Drbohlav himself, indeed, considerably extended the first findings during a stay at Paris in

1925. It is safe to say that Boeck and Drbohlav, and their culture-media, will be remembered as long as the study of intestinal protozoa continues; and for this reason, if for no other, the name of Jaroslav Drbohlav will ever occupy an honourable place not only in his own country but also in the history of microbiology.

I am indebted to Dr. F. M. Berger, a mutual friend and former colleague of Dr. Drbohlav, for some of the data in this note—obtained from Czech sources not generally available. CLIFFORD DOBELL

Prof. T. W. Griffith, C.M.G.

THOMAS WARDROP GRIFFITH, emeritus professor of medicine in the University of Leeds and honorary consulting physician in the General Infirmary in Leeds, died in his eighty-sixth year on October 21.

After graduation with highest honours and demonstrating in anatomy under Sir John Struthers for a short period, Griffith chose a clinical career and was successively resident medical officer, honorary assistant physician and honorary physician in the General Infirmary, Leeds. Concurrently, from 1887 until 1910, he filled the chair of anatomy in the University of Leeds, until on promotion to the post of full physician he was transferred to the chair of medicine, which he held until 1925. He served in the 2nd Northern General Hospital during 1914–19, having charge of the special cardiac centre. From 1918 until 1927 he sat on the General Medical Council.

The chair of anatomy at Leeds carried a trifling honorarium, but Griffith spent a large amount of time in its service. The department in the new building (1893) was planned with skill and foresight and was about the best in Great Britain. With his own hands he made a large number of preparations for the museum and for illustration in lectures. In the course of time he amassed a remarkable collection of specimens of abnormalities of the heart, many of which are described in the medical journals. His best known work (with Oliver) was on the distribution of the cutaneous fibres of the thoracic nerves, which demonstrated that the segmental zones were lower and more horizontal than the line of the nerve trunks.

Griffith's daily morning lecture was given with zest, clear, convincing, often dramatic; enlivened by the use of his own strong and supple frame in demonstrating the movements of joints and actions of muscles and by many apt references to the use of anatomical knowledge in clinical work: his anatomy was indeed 'living anatomy', and the attention of his audience was never allowed to flag. His visits to the dissecting room were a stimulating breeze.

In the Leeds Infirmary, Griffith exercised the same skill as was shown in planning the Anatomy School by taking the chief part in the conversion of a part of the hospital into a teaching block to accommodate classes and clinics for the trebled post-war entry of students in 1919–20. Punctuality and complete discharge of all honorary public duties were unfailing. The generations of students whom he encouraged, stimulated and disciplined remember him with regard, and have been grieved to know that this most active and productive life has been clouded by progressive blindness. He was the last of the Victorian clinicians who professed a fundamental subject, the men who begat, and weaned, all the provincial medical schools. J. KAY JAMIESON

Prof. George Baborovský

DR. GEORGE BABOROVSKÝ, professor of physical chemistry at the Technical College, Brno, died on October 10 at the age of seventy-one. Born at the west Bohemian mining town of Přibram, he graduated at Prague in 1902 and then spent three years under Ostwald at Leipzig. He returned to Prague to become assistant professor of physical chemistry, but in 1911 he went to the Brno Technical College as full professor. The College was given university rank in 1919, and from his laboratory Baborovský published a series of researches dealing with electrochemical subjects, especially the hydration of ions. In 1917 he introduced a new method for finding the absolute hydration by determinations of the true transport numbers of the electrolytes concerned.

Several of Baborovský's later papers are available in English as they appeared in the *Collection of Czechoslovak Chemical Communications*, 1929–38. Baborovský also wrote the standard Czech text-book on physical chemistry, and during his enforced idleness after 1939 he compiled a comprehensive treatise on colloids which was published in 1944 under the title "Colloids Everywhere". G. DRUCE

Dr. A. H. Belinfante

AMONG the Continental men of science to perish in the Terezin concentration camp was the promising young Dutch physical chemist, Dr. Adriaan Hendrik Belinfante. He was deported to Terezin from Holland, together with his wife, mother and children, in February 1944. The mother, who was seventy-six, died in April, but Belinfante and his wife survived until October of that year. He was forty-four years of age. His scientific work, most of which was published in the *Recueil de travaux chimiques des Pays-bas*, dealt with the mechanism of certain oxidation processes, autoxidation, 'induced oxidation' and similar phenomena; it covered such widely different reactions as the thermit process with aluminium, molybdenum oxide and calcium fluoride, explosions with benzene–air mixtures and the role of induced oxidation of lactic acid in relation to the cancer problem.

Mr. A. W. Lupton

THE death occurred on October 1 of Mr. A. W. Lupton, senior lecturer in pharmacy and pharmaceutical chemistry in the University of Leeds. Mr. Lupton was appointed a full-time lecturer in 1933 when the work of the Leeds College of Pharmacy, of which he had for some time been head, was taken over by the University. He was responsible for the training of students for the professional qualifications in pharmacy, as well as for the instruction of medical and dental students, and he did much to raise the status of pharmacy in the University.

WE regret to announce the following deaths:

Prof. R. M. Ferrier, emeritus professor of civil engineering, University of Bristol, on October 28.

Prof. Percy F. Frankland, F.R.S., emeritus professor of chemistry in the University of Birmingham, on October 28, aged eighty-eight.

Dr. A. Liebert, sometime director of the Kant-Gesellschaft and extra-ordinary professor of philosophy in the University of Berlin, aged sixty-eight.

NEWS and VIEWS

University of Bristol : Plans for Extension

On October 29, at a meeting of representative men and women of the region, an appeal was launched for funds for the extension of the University of Bristol. The University has for some years been engaged in making plans for its future expansion and development. Although it possesses several fine buildings, certain departments are already cramped. In the Medical Faculty, teaching has been dispersed and accommodation was severely restricted even before the Department of Anatomy was destroyed in an air raid. With the expansion which must take place to meet the demands for both undergraduate teaching and graduate training and research, new buildings are a necessity. The scope of the Faculty of Engineering has recently been enlarged by the foundation of the Sir George White chair of aeronautical engineering. The Faculty is housed at some distance from the University in a building on which it has no permanent hold, and new quarters are necessary here, too. Both in the Faculties of Arts and Science certain departments require more room, especially in view of the growing numbers of staff and scholars engaged on research.

Apart from such natural expansion, several new departments are in preparation. It has long been felt that the University of a great agricultural region should make a direct contribution to the interests of the countryside, but it has also been felt that work already done elsewhere in the south of England should not be duplicated. The proposal that a School of Veterinary Science should be established at Bristol has now provided an opportunity which will be taken. A Field Station is already available, and the pre-clinical teaching will be provided for in the new Medical School. It is further proposed to institute a graduate diploma in horticulture for students already possessing an honours degree in one of the sciences bearing on that subject. The purpose is to provide men with a training in fundamental science capable of carrying out research on applied lines. This will be done in association with the Research Station at Long Ashton The University also proposes to set up an Institute of Education on the lines of Scheme A of the McNair Report, and will thus assume responsibility for the training of teachers in a group of associated colleges.

The demand for a general increase in the numbers of men and women taking university courses lays a special obligation on a University formerly small in numbers and therefore capable of economic expansion, and it is proposed to plan for an ultimate student population of some 3,000. It has been urged on the University that its situation, and the amenities it enjoys, make it specially suitable for development on residential lines. The suggestion is welcome, and fits in with past policy. There are already three fine Halls which formerly allowed all students not living in the city to spend one or two years in residence: further, the University had been successful in evolving a system of student life intermediate between the collegiate and the institutional. It has just acquired four mansions which give a material increase in living room. As a most important item in its plans, it puts the provision of several new Halls. The site for these, in fine and open surroundings, within reasonable distance of the University, is already available, and an immediate objective is the building of two new Halls to be called after Mr. Winston Churchill, chancellor of the University, with whose name the appeal has been associated.

Universities Quarterly

The need for a journal wholly devoted to university education and the vital problems affecting university development has grown more urgent in recent years. *Universities Quarterly*, the first number of which has just been published, is an attempt to meet this need. Its primary purpose is to discuss—"with complete freedom and from all angles"—what can best be done by the universities themselves, industry and the Government, to enable the universities to adapt their teaching, research, and, if need be, guiding philosophy, to meet the demands of a rapidly changing society. The journal is not, in consequence, intended solely—or even primarily—for members of university staffs. Rather is it the intention of the editorial board, of which Sir Ernest Simon is chairman, that many of the articles will be of interest also to those engaged in public life, the Civil Service, local government, and teaching work in secondary schools and technical colleges. Catholicity of appeal is, perhaps, the most notable feature of the first number. Bertrand Russell urges that most students should learn something of the fundamentals of philosophic thinking. Bonamy Dobrée discusses knowledge for its own sake. Sir William Larke writes on industry and the universities. Sir Ernest Simon deals with the problems of expansion and development facing the universities as a result of the growing national demand for higher education. Other features include an article by Dr. O. C. Carmichael on "Higher Education in the United States", a series of short contributions on "Why Compulsory Philology ?", and book reviews. The last, which ought undoubtedly to have a major place in a journal of this type, is unfortunately the weakest feature in the first number. *Universities Quarterly* is published by Turnstile Press, Ltd., 10 Great Turnstile, London, W.C.1, and the price is 5*s*. per issue.

Scientific Instrument Manufacturers' Association of Great Britain

The annual report, for 1945–46, of the president and council of the Scientific Instrument Manufacturers' Association of Great Britain Ltd. (from the Association, River Plate House, 12–13 South Place, London, E.C.2) remarks on the growing appreciation of the part that scientific instruments and laboratory apparatus play in science, industry and education, and how this has, to a large extent, contributed to the continued expansion and progress of the Association. The report records that, during the year under review, twelve new firms joined the Association, bringing its total membership up to eighty-six, and that the formation of a new section, dealing with electronics, is under consideration. At the last annual general meeting, the council was empowered to appoint a permanent director of the Association, and although seventy replies were received to advertisements in the Press, it was decided, after full consideration, that an approach be made to the British Scientific Instruments Research Association, with which the Scientific Instrument Manufacturers Association actively collaborates, for the appointment of Mr. A. J. Philpot as director of both bodies.

Many new problems have faced the Association during the year, and the council has expressed, through individuals or appropriate committees, the Association's views on such matters as the de-requisition of business premises, the call-up of young technicians, the control and future of German industry, the disposal of surplus scientific instruments, and the post-war protection of the British scientific instrument industry. During the year, valuable contacts were made with the Scientific Apparatus Manufacturers Association of America and with the French Syndicat Général de l'Optique et des Instrument de Précision. Previous personal contacts made in Sweden led to the successful exhibition of British scientific instruments held in Stockholm during May–June last, in which forty members of the Association took part (see *Nature*, 158, 66; 1946). The Association is taking part in the "Britain Can Make It" Exhibition, and participation in an exhibition to be held in Brussels, as well as in the 1947 British Industries Fair, is stated to be under active consideration.

Royal Observatory, Greenwich: Annual Report

THE report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, covers the period May 1, 1945, to April 30, 1946, and deals with the usual matters presented at the annual visitation. The Astronomer Royal was able to resume occupation on October 1, 1945, when a portion of the damaged Flamsteed House was repaired, and a small amount of work has been carried out at the Observatory, but no structural repairs have been attempted up to the present. The covering of the dome of the 28-in. equatorial, which suffered on several occasions from the effects of blast, is beyond repair, and it will not be renewed in view of the pending removal of the Observatory to Herstmonceux. The telescope will be dismantled as soon as storage accommodation is available, and will be re-erected on the new site. It is impossible to provide even an outline of the lengthy report, which should be read by all who are interested in the work and in particular in the future of the Royal Observatory.

One matter in connexion with this latter point is of supreme importance and is dealt with very clearly at the end of the report. It is most essential, if the Royal Observatory is to continue its work in contributing to the development of astronomical science, that the basic grades should be recruited at a higher level. Post-graduate research for students from the universities should be provided for by the Royal Observatory, and it is hoped that some such scheme will materialize in the near future. While proposals have been submitted for regrading its staff (including that of the Nautical Almanac Office) on the basis of the reorganised Scientific Civil Service, no decision has yet been made. At present both the salaries and prospects of promotion of the Observatory staff are very inferior to those in other scientific establishments, and unless improvements are made the recruitment of staff to fill vacancies must present serious difficulties. This is a matter of the utmost importance, and it is time that the British public was aware of the dangers to the development of astronomical science in Great Britain if overdue reforms are not forthcoming.

Research Council of Alberta

THE twenty-sixth annual report of the Research Council of Alberta (Edmonton, Alberta: King's Printer), covering the year 1945, includes lists of members of the Council and the Technical Advisory Committee, the technical staff and of the publications of the Council. Most of the investigations in progress in the previous year were continued, new investigations including a soils survey in co-operation with the Dominion Government and studies of the possibilities for the commercial utilization of cereal straws and of Alberta poplar Difficulties in obtaining technical staff, services and supplies continued to handicap the work. Much of the work on bituminous sands was concerned with the critical problem of freeing the crude oil, recovered by the separation unit, from water, sand and silt, and preparation of it in suitable form for the refinery. Study of the hot-water separation method continued, and the most significant advance in the year was the discovery that the silt and clay present in bituminous sand powerfully assist displacement of the oil from the sand by hot water Three papers on this work were published during the year. A detailed report on the use of Alberta coals in automatic domestic stokers was issued as Report No. 46. Other fuel investigations related to briquetting, while the major geological project was a field investigation of part of the Highwood coal area. A report on the "Geology of the Red Deer and Rosebud Sheets" was published during the year, and a study of the Fischer – Tropsch synthesis of petrol and other liquid fuels from natural gas has been concerned with the reduction and conditioning of catalysts. A co-operative soils survey programme was planned with the soil survey department of the Dominion Government, but was not completed owing to shortage of qualified staff, and it will be some time before the detailed reports are available. A study is also in progress of the periodic rise and fall in the number of rabbits, fur-bearing and other animals and birds at intervals of about ten years.

A paper by E. Stansfield, chief research engineer of the Research Council of Alberta, on recent work of the Council, presented to the Annual Western Institute of the Canadian Institute of Mining and Metallurgy in October 1945, has now been issued as Contribution 10 of the Research Council, and the picture it gives of the work of Council is supplemented by a list of the more important items in the programme for 1946–47 and a summary of the appropriations granted by the legislature. Mr. Stansfield, in his paper, refers briefly to the studies initiated on the biological cycle, to earlier work on the wetting of coal, current work on coal for automatic domestic stokers, and on low-temperature carbonization, portable gas producers, briquetting, etc.

Forestry in China

IN *Acta Brevia Sinensia* (No. 11; 1945) some interesting information is given on Chinese forests and forest resources, a subject upon which all too little is known in Europe. Abstracts are given from papers or forthcoming books on half a dozen aspects of forestry procedure, analyses of the forest, extraction, etc., with a note on the Forest Products Laboratory. The report on a survey of the forest resources of China for railway sleepers proposed in south-west China records investigations in the five provinces of west Sikong, south Szechuan, south-east Kweichow, north Kwangsi and south Hunan. Several forests hitherto unknown were explored for the first time. Among the more important of these are the evergreen forests of Loochen in the region between the provinces of Kweichow and Kwangsi, and the mixed forest at the upper part of Nien Shao Ho, south-east Kweichow. The lumber markets at Yaan, Hokiang, Kweiling and Hengyang were also investigated with reference to their possible supplies to the railways. In a preliminary study of Chinese forests and timbers (to be published shortly in English) the forests are discussed under the five divisions: (1) the Manchurian Forest, (2) the north-west, (3) the south-west, (4) the Nanling, and (5) the southern hardwoods forest. In Part 2 an enumeration of the most important and commonest Chinese timbers is given, a most interesting item; among others are Chinese fir, pine, spruce, larch, Chinese cedar, hemlock, oaks, birch, maple, poplar, schima, red gum, walnut, Chinese mahogany, beech, elm, ash, basswood, red alder, "other common softwoods and hardwoods", whatever that means; and others with native names only. A map shows Chinese forest regions, and a table of estimated forest resources and lumber markets is included.

There is also a brief account of the Forest Products Laboratory, which was organised in 1939 at Peipei, Chungking, and forms a unit of the National Bureau of Industrial Research at the Ministry of Economic Affairs. Its main purpose is to investigate the properties of Chinese timbers to promote their better utilization. The inquiry in connexion with the chief of the timbers will be carried out as follows: their proper names, supplies, structure, physico-chemical, seasoning, preserving and wood-working properties. Owing to the destruction of the original building in an air raid, the laboratory is now at Kaiting. During the past five years considerable assistance has been received from the Fan Memorial Institute of Biology, the Rockefeller Foundation, the Agricultural Promotion Association, the National Wu Han University and the British Council Cultural Scientific Mission in China.

Royal Scottish Museum, Edinburgh

THE progressive activity of the Royal Scottish Museum is shown by the Director's report for the year 1945. Having been closed during 1939–43, no time has been lost in carrying out vigorous schemes to "recapture its lost public and to attract the younger generation who knew it not". The organisation of numerous temporary exhibitions relevant to a variety of topical and educational subjects; lectures of strong Scottish interest; the practical support of the activities of outside educational and cultural institutions; the resumption of services for visiting classes of school children and various adult educational groups, and the regular showing of instructive motion films, have all contributed to the winning of the firm public appreciation which the Royal Scottish Museum merits. A very popular feature connected with some of the special exhibitions was the introduction of demonstrations which "livened the exhibits and encouraged closer study of both processes and products".

This report and those from other museums exploring similar fields of interest indicate plainly enough that activity of this kind will be, in future, a necessity if there is to be a general public appreciation and use of museum services as a whole. The opportunity afforded by the war-time evacuation of collections for the reorganisation of the 'old' in the interests of the 'new' has not been missed in Edinburgh, for it is reported that plans for a revised layout of the collections were put into operation during the year. Among the several important acquisitions reported, mention may be made of the gift by Mr. J. R. Lockie of a collection of more than 4,400 Communion tokens (previously on loan to the Museum); the Museum's collection of these now becomes one of the largest and finest in existence.

A New Synthetic Insecticide

THE discovery of the insecticidal properties of D.D.T. (the *para, para*-isomer of dichlorodiphenyltrichloroethane) closely followed by the isolation of the γ-isomer of benzene-hexachloride, which is even more toxic to some insects, has provided a great stimulus to the search for new and still more potent substances—especially for substances in which it may be possible to secure proprietary rights The two insecticides above are both highly chlorinated ring compounds, and it is in this group of materials that the search seems to be most actively prosecuted at the present time. The latest product is a chemical of unrevealed composition with the empirical formula $C_{10}H_6Cl_8$. It has been produced by the Velsicol Corporation in Chicago under the name of "Velsicol 1068", and is to be marketed in Great Britain by the Hygienic Chemical Co., Ltd. It is a viscous, colourless, odourless liquid, less volatile than benzene hexachloride ('Gammexane'), more volatile than D.D.T. In solubility it resembles these substances, and in toxicity to insects it comes somewhere between them. The same applies apparently to its toxicity to mammals. More extensive trials will be needed before the relative merits of these materials can be established and the best uses of "Velsicol 1068" defined. It is to be hoped that the structural formula of the compound will soon be published.

Early Metallurgy

THE Royal Anthropological Institute has appointed a Mining and Metallurgical Committee to investigate problems of early metallurgy, as part of its scheme for group studies of the evolution of man. Among the first matters to be studied by the Committee is man's early use of copper When found in its metallic form, the element is known as 'native' copper, and metal of this kind undoubtedly formed the earliest sources of copper supply. Samples from various parts of the world are being collected by the Committee and analysed with the object, if possible, of relating their particular composition to that of ancient specimens of copper work. The Committee includes the following: Mr. C. E N. Bromehead (Geological Survey and Museum); Prof. V. Gordon Childe (Institute of Archæology, London); Mr. H. H. Coghlan (chairman); Prof. C. H. Desch; Dr. Oliver Davies (Queen's University of Belfast); Mr. A. Digby (British Museum); Prof. C. F. C. Hawkes (University of Oxford); Dr. W. Lamb (secretary); Mr. T. K. Penniman (Pitt Rivers Museum, Oxford); Prof. Stuart Piggott (University of Edinburgh); Dr. H. J. Plenderleith (British Museum); Dr. J. Raftery (National Museum, Dublin); Mr. B. Webster Smith (Copper Development Association).

List of Awards for Scientific Research

A FOURTH edition (June 1946) of the "List of Whole-Time Awards for Scientific Research, other than Professorships, offered by Public and Private Bodies in Great Britain and Northern Ireland", prepared primarily for the use of the Commissioners for the Exhibition of 1851, follows the same lines as its predecessors, of which the last was issued in November 1937 (London: Roy. Comm. Exhib. 1851. 1*s*.). It does not include awards of less than £150 a year, or scholarships for special branches of medicine or veterinary science. It also omits awards offered by universities and scientific societies exclusively for the benefits of their own members, and awards for which British subjects are not eligible. An endeavour has been made to bring the information fully up to date, but the post-war policy of some of the bodies responsible for the administration of awards has not been finally settled. Some new awards, founded by recent benefactions, may also have been omitted through lack of information. The awards are arranged in three classes according to whether they are open awards offered (1) by private and public bodies other than universities or colleges, (2) by universities and colleges, and (3) awards restricted to candidates from particular localities or institutions. There is a subject index and a general index.

Sintered Glass

A NEW technique for the production of complex glass-metal structures, such as the bases of thermionic valves, is described by E. G. Dorgelo in the January 1946 issue of the *Philips Technical Review*, vol. 8 The process consists in pressing finely powdered glass into a graphite mould in which the metal parts are supported, and in sintering it in a mixed nitrogen – hydrogen atmosphere by high-frequency induction heating. The finished product is opalescent because of the large number of gas bubbles, the average diameter of which is about 50 microns, which are trapped in the fused glass; but these are said not to affect the mechanical properties detrimentally, while in respect of electrical breakdown it is suggested that the powdered-glass product is likely to be superior to that of ordinary glass in which, by mischance, air bubbles of larger size have become enclosed.

Observing Ultra-violet Radiation at a Height of 100 Miles

Sky and Telescope of August has a short note which refers to the films developed by the Eastman Kodak Company with special fluorescent coatings for recording ultra-violet radiation They are to be used in spectrographs mounted in the noses of V2 rockets, and the ultra-violet radiation of sunlight will be recorded when the rockets reach altitudes of about 100 miles. The glow on the fluorescent coating produced by the ultra-violet light is recorded on the film.

University of Sheffield: Appointments

RECENT appointments by the Council of the University of Sheffield include the following: Dr. W. S. Bullough (Sorby Fellow), to be honorary lecturer in zoology; Dr. May H. Beattie, to be honorary demonstrator in bacteriology; Derek R. Wood, to be lecturer in pharmacology; D. K. Hill and H. E. Taylor, to be lecturers in the Department of Glass Technology.

Colonial Service Appointments

THE following appointments in the Colonial Service have been announced: M. A. Barrett, to be agricultural officer, Kenya; J. Bowden, to be entomologist, Gold Coast, A. Simpson, to be geologist, Nigeria; R. C. Clarke, to be land surveyor, Hong Kong; R. S. A. Beauchamp, to be director of freshwater fisheries, Research Station, Jinja, Uganda; G. A. W. Dove, to be geologist, Lands and Mines Department, British Guiana, J. B. Pollock, to be metallurgist chemist, Uganda; B. W. Thompson, to be professional assistant at the Royal Observatory, Hong Kong; R. P. Davidson, agricultural officer, Malaya, to be agricultural officer, Uganda; T. R Hayes, senior agricultural officer, Uganda, to be principal agricultural officer, Uganda; M. G. de Courcy-Ireland, agricultural officer, Uganda, to be senior agricultural officer, Uganda; W. J. M. Irving, agricultural officer, Uganda, to be senior agricultural officer, Uganda; C. L. Skidmore, senior agricultural officer, Gold Coast, to be assistant director of agriculture, Gold Coast; J. M. Wingate, senior agricultural officer, Gold Coast, to be assistant director of agriculture, Gold Coast; G. R. G. Kerr, conservator of forests, Nigeria, to be regional assistant chief conservator of forests, Nigeria; D. R. Rosevear, conservator of forests, Nigeria, to be regional assistant chief conservator of forests, Nigeria; N. S. Stevenson, conservator of forests, Nigeria, to be regional assistant chief conservator of forests, Nigeria; M. Perks, surveyor, Nigeria, to be surveyor, Northern Rhodesia.

Announcements

PROF. M. STACEY, of the University of Birmingham, will deliver the Tilden Lecture of the Chemical Society on December 5 at 7.30 p.m., his subject will be "Macromolecules Synthesized by Micro-organisms".

THE Institution of Naval Architects is offering the following scholarships, tenable for three or four years, according to the length of the course at the university selected, for competition in 1947 *Naval Architecture:* Vickers-Armstrongs, £200 a year; Denny, £130 a year, at the University of Glasgow only; *Marine Engineering:* Yarrow, £170 a year. Entries close on May 31, 1947. Full particulars can be obtained from the secretary of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1

DR. A. BOERGER, of the University of Montevideo, director of the Agricultural Research and Plant Breeding Station of La Estanzuela, Uruguay, since 1912, president of the Uruguayan National Commission on the Forage Crop Problem, and author of several books of major importance on agricultural and grassland research in the La Plata region, has received the degrees of doctor *honoris causa* of the University of Montevideo, and of doctor *honoris causa* in agrarian sciences of the University of Buenos Aires. In conferring these distinctions, the authorities of the Universities acknowledged in warm terms the indebtedness of the two great stock-raising countries of the La Plata basin to Dr. Boerger's life-time of devotion to agricultural and grassland research, a devotion which has redounded greatly to the economic advantage of both countries.

IN the article "The Multiplicity of Foramina Mentalia in a Human Mandible from the Copper Age of Anatolia" (*Nature*, June 15, p. 792), the author is described as "professor". Dr. Muzaffer Senyurek points out that he holds the post of assistant professor only.

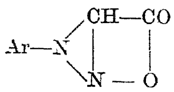
ERRATUM. In the article "Recent Additions to the London Zoo" (*Nature*, Nov. 2, p. 637), the Mau escarpment was described as in "western" Uganda; this should read "eastern" Uganda.

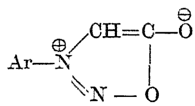
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Structure of the 'Sydnones'

It has been shown by J. C. Earl[1] that the N-nitroso-N-arylglycines, for example, Ph.N(NO).CH_2.CO_2H, on treatment with acetic anhydride lose a molecule of water, giving monomolecular anhydro derivatives which have been termed 'sydnones'. The structure tentatively suggested for these compounds contains the fused three- and four-membered ring system (I), and is unacceptable for a number of reasons which need not be enumerated.


(I)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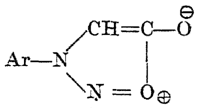
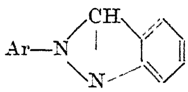

(III)


(IV)

As shown by Earl, the 'sydnones' are converted into the original N-nitroso-N-arylglycines by hydrolysis with alkali, and it is therefore most improbable that any molecular rearrangement, such as migration of the aryl group, occurs during their formation. The five-membered ring system shown in (I) is, therefore, almost certainly present in the 'sydnones'. A modification of the structure proposed by Earl, however, avoids the obvious difficulties inherent in the formulation (I); it also allows a ready explanation of the stability of the compounds and accounts equally satisfactorily for their properties. The modification now advanced omits the bridge bond in (I), and substitutes a hybrid structure derived from a number of ionic states of which there are, for example, eight zwitterionic forms (not all of equal probability), two of which are shown in formulæ (II) and (III). On this view the 'sydnones' are partially aromatic in character, and might be expected to possess the degree of stability which they, in fact, show.

The problem of the structure of the 'sydnones' is closely related to that of the 2-substituted indazoles (IV; shown with a bridge bond to compare with I) and related compounds such as anthranil, 2-substituted benztriazoles, etc., for which a hybrid, largely zwitterionic structure has already been advanced by one of us[2]. Work on the structure of this type of molecule and on the 'sydnones' is in progress, and a full report will be published elsewhere.

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Oct. 9.

[1] Earl, J. C., and Mackney, A. W., *J. Chem. Soc.*, 899 (1935). Earl, J. C., and Eade, R. A., *J. Chem. Soc*, 591 (1946).
[2] Baker, W., Tilden Lecture, *J. Chem. Soc.*, 267 (1945).

Catalytic Oxidation of Ascorbic Acid

Barron *et al.*[1] showed that ascorbic acid is not autoxidizable in acid solutions up to *p*H 7. They investigated the catalytic effect of salts of manganese, nickel, iron, cobalt, calcium and copper at *p*H 4–6 and found that copper alone had a marked catalytic effect. Mack and Kertesz[2] found that iron had no catalytic effect alone but increased the catalytic effect of copper.

Investigations in this Laboratory have shown that catalysis by ferrous iron is negligible above *p*H 2 but considerable at *p*H 1 and below. In contrast, copper catalysis decreases with decreasing *p*H and becomes negligible below *p*H 1. The accompanying table shows results of studies in solutions of 0 1 *M* sodium acetate adjusted to various *p*H levels with sulphuric acid. The solutions contained initially 20 mgm. of ascorbic acid per 100 ml. and were aerated rapidly at 40° C.

Catalyst added	Per cent oxidation in 5 min at *p*H			
	0 4	1 0	2 0	3 0
Nil	0	0	0	0
Cu″ (10 p.p m.)	0	0 3	7 0	54 3
Fe″ (10 p p m.)	43 0	20 8	0 9	0 9

At *p*H 0·4, copper has practically no catalytic effect but actually reduces the catalytic effect of iron. These results, in addition to their theoretical interest, are of importance in relation to the determination of ascorbic acid in canned foods. Further details will be published later.

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Oct. 15.

[1] Barron, E S G, *et al*, *J. Biol Chem*, **112**, 625 (1936).
[2] Mack G L, and Kertesz, Z. I, *Food Res*, **1**, 377 (1936).

A Direct Method for Determining the Index of Refraction of Thin Films

In working with high-frequency discharges obtained in air, at a pressure of about 1 mm., by the use of external electrodes surrounding a glass tube, an interference pattern was observed after a run of twenty hours or more The pattern was visible both inside the tube at the edges of the electrodes and on glass strips placed under the electrodes within the tube. Patterns were obtained on clear strips of glass and on strips previously coated with thin metallic layers. Fig. 1, an enlarged photograph taken by sodium light reflected from the surface of a strip, shows a characteristic pattern which was formed on that portion of the strip immediately under one of the electrodes. The pattern appears to be similar in nature to those observed by Bochstahler and Overbeck[1], Nathanson[2], Nathanson and Bartberger[3] and others, in sputtering discharges, and is due apparently either to the deposition of a thin layer

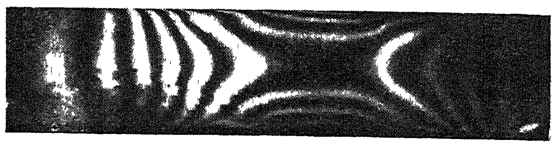
Fig. 1

Fig 2

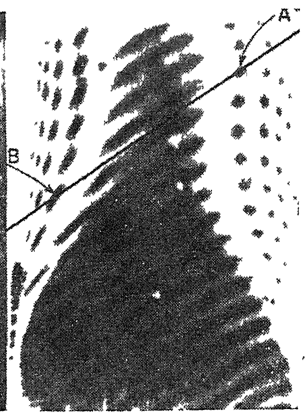

Fig 3

of some transparent material, or to some action of the discharge on the surface of the glass. If we assume the first hypothesis, the maximum thickness of the deposit can be shown to be of the order of 5 wave-lengths (in the medium). Since this thickness is attained only very near the edge of the deposit, where it is a maximum, the total amount of material in a deposit must be very small and analysis by ordinary methods extremely difficult. It was thus thought advisable to obtain some clue as to the nature of the deposit by determining its index of refraction by means of what seems to be a new method.

The method was suggested by the recent work of Tolansky[4] on the determination of the contours of nearly plane surfaces by means of multiple reflexion fringes. A layer of silver with reflexion coefficient of the order of 0·9 was deposited by evaporation *in vacuo* on one surface of a compensating plate taken from an old Michelson's interferometer. The plate, about 15 mm. × 20 mm. × 5 mm., was placed with its silvered side up in a high-frequency discharge tube of 3 cm. diameter, containing air, in such a way that one end protruded about 3 mm. beyond the region surrounded by one of the external sleeve electrodes. A discharge was maintained in the tube for several hours, after which the plate was removed. The result (reproduced as Fig. 2) shows that the silver was removed from the centre of the plate and also from the end outside the electrode, a phenomenon related to the removal action of high-frequency discharges discussed by Hay[5]. On the remainder of the area, however, a deposit showing the interference pattern appears to have protected the silver coat, which is intact.

A second layer of silver was then evaporated *on top of the deposit*, and at the same time on one of the surfaces of another similar plate from the interferometer. The two silvered surfaces were then placed in close proximity in a device which allowed adjustment to be made until approximate parallelism could be attained.

Viewed in transmitted monochromatic light, the result, as shown in Fig. 3, showed two superimposed sets of multiple reflexion fringes, one within the medium showing the original pattern, and the other in the air gap between the plates. Points A and B (Fig. 3) are on the same fringe in each set, hence they represent regions at which the thicknesses of both the air gap and the deposit, as well as the distance between the two glass surfaces, are equal. Since the glass surfaces are optically plane, the distance between them must be constant everywhere on the line AB. The distance along any line parallel to AB must also be constant.

Thus, if the number of fringes due to reflexion in the air gap that are cut by a segment of a line parallel to AB is a, and the number of fringes of the set in the medium cut by the same segment is b, the index of refraction of the medium with respect to air is evidently b/a, since the change in the thickness of the air gap is entirely due to the change in the thickness of the medium along the line segment.

Using this method, the index of the medium was found by one of us (R. W. S.) to be $1\cdot49 \pm 0\cdot012$, for $\lambda = 5460$.

Further work is in progress to determine the origin and nature of these deposits, as well as their indices of refraction and dispersion

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Sept. 25.

[1] Bochstahler, L I, and Overbeck, C J., *Phys Rev.*, **37**, 465 (1931).
[2] Nathanson, J. B, *Phys Rev*, **41**, 373 (1932)
[3] Nathanson, J B., and Bartberger, C. L., *J Opt Soc. Amer.*, **29**, 417 (1939)
[4] Tolansky, S., *Proc Roy. Soc.*, A, **184**, 41 (1945)
[5] Hay, R H, *Can. J. Res.*, **16**, 191 (1938)

Luminescence Processes in Zinc Sulphide Phosphors

In a recent communication in *Nature*[1], derivations of phosphorescence decay equations have been made, based on the electron trapping mechanism, which assume retrapping of electrons to be an important part of the process. The writers direct attention to two statements from papers by Randall and Wilkins[2] which, when thus isolated from their context, appear to contradict each other. Klasens and Wise assume in their letter that electron traps and luminescence impurity centres are independent of each other. Their subsequent theoretical treatment of the decay process is based on the above assumptions.

We have recently completed extensive studies of the phosphorescence and thermoluminescence characteristics of zinc sulphides and other phosphors governed by electron-trapping mechanisms, and papers are in preparation on this work. There is no doubt that retrapping of electrons can give rise to considerable modification of the theory of phosphorescence and thermoluminescence for phosphors having a single depth of trap. The basic equations for the emission given by Randall and Wilkins[2] are thereby altered and become:

$$I = -\frac{dn}{dt} = \frac{c.n^2 s}{N} \exp -E/kT, \quad . \quad . \quad (1)$$

where I is the luminescence intensity, n the number of trapped electrons in the N available traps, c and s are constants, and E is the trap depth. Equations 1 lead to new expressions for the decay of phosphorescence and the thermal glow-temperature variation.

Experimental evidence from our studies, which include investigation of the origin of dielectric changes in phosphors, the behaviour of phosphors with more than one activating impurity and the effects of 'killer' impurity, flux and preparation conditions, indicates two important facts: (*a*) Electron traps are closely associated with the neighbourhood of the luminescence centres and can be formed by the introduction of the impurity giving rise to the centres. (*b*) Retrapping of electrons is usually a negligible process in the luminescence mechanism of zinc sulphide and other specific phosphors. This statement is capable of explanation in terms of that in (*a*).

An earlier communication in *Nature*[3], from Mr. Klasens alone, postulated a theoretical explanation of the energy exchange in sulphide phosphors with more than one impurity. Experimental facts arising from our studies do not support this simple theory. As an example, the figure given in this earlier communication showing the effect of nickel on a zinc sulphide–silver-activated phosphor agrees approximately with our results. However, the increase of nickel content not only affects the ratio of killer centres to emission centres, but also causes a large change in the E value contained in the expression for the parameter c. The theory does not explain the fluorescence-excitation intensity relations found for very low excitation of these phosphors in the temperature region where the value of c becomes important.

We believe that Mr. Klasens' views are not adequately supported by experimental evidence, which seems to favour different basic assumptions.

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Physics Department,
University of Birmingham.
Oct. 5.

[1] Klasens, H. A., and Wise, M. E , *Nature*, 158, 483 (1946)
[2] Randall, J. T., and Wilkins, M. H. F., *Proc. Roy. Soc.*, A, 184, 366 and 390 (1945)
[3] Klasens, H. A , *Nature*, 158, 306 (1946)

Diamagnetic Susceptibility of Isomerides

IN a discussion of investigations on the magnetic susceptibilities of aliphatic acids and esters—carried out just before the outbreak of war and published[1] in 1943—Angus and Hill directed attention to certain regular differences between the susceptibilities of straight- and branched-chain compounds and briefly reviewed existing data.

When the study of magnetic susceptibilities was resumed by us about a year ago, investigation of various types of isomerides was planned and, in the first instance, more particularly aldehyde-ketone isomerism and the isomers of methyl benzoate and their analogues, since, from the few relevant published data[2], it appeared that such isomerides had identical susceptibilities. While these investigations were proceeding, there appeared in the issue for March 12 of the *Comptes rendus*[3] a paper by Pascal and Pacault; unfortunately, it was only a few days ago that this paper became available to us. Pascal and Pacault discuss, in a generally adverse manner, the results on isomers of aliphatic acids and esters[1], and suggest the desirability for carrying out further investigation on isomerides which appeared to have identical susceptibilities. This work was, as has been stated, in hand and has now reached a sufficiently advanced stage to make a preliminary report appear to be desirable, although reserving a discussion of the significance of susceptibility differences until the planned programme has been completed and the values now given have been adequately confirmed. It is not proposed to refute here the general criticisms contained in Pascal and Pacault's paper; that can and will be done elsewhere later.

So far our work on aldehyde-ketone isomerides has shown that the aldehyde is slightly more diamagnetic than the isomeric ketone, although, with our present data, the difference shows a small but not a constant value. For example, the value for acetone is $0 \cdot 4 \times 10^{-6}$ less diamagnetic than propionaldehyde, while with methyl amyl ketone and œnanthaldehyde the difference is $0 \cdot 7 \times 10^{-6}$.

The results for the other type of isomerism which we have studied are more self-consistent and give more regular differences, as is shown in the accompanying table showing the values of $-\chi_M$ (multiplied by 10^6) obtained.

Phenyl-acetates	Benzyl esters	Benzoates	Phenyl esters
—	Formate 81·43	Me 81·54	Acetate 82·04
Me 92·73	Acetate 93 18	Et 93 32	Propionate 93·79
Et 104·27	—	Pr 105 00	*n*-Butyrate 105·46

These results show clearly that the isomerides do not have identical susceptibilities.

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X-Ray Examination of Self-Recovery in Copper

A COMMUNICATION by L. L. Van Reijen[1] refers to a recovery effect after an interval of some months in filed copper powder. This was shown by X-ray transmission photographs of a thin layer of the powder specimen. He used the same interval of time when verifying his observation, and presumably did not follow the progress of recovery in detail. However, in view of his reference to rotation powder photographs taken by Megaw, Lipson and Stokes[2,3], in which recovery was detected some days after the preparation of the powder, it may be of interest to report that we have detected the self-recovery of filings of electrolytic tough pitch copper several days after filing, in both transmission photographs and rotation powder photographs

The transmission method is preferable for following the progress of recovery during its later stages; thus the diffraction pattern obtained with the freshly filed copper shows diffuse diffraction rings of uniform intensity, and after six days a number of intense sharply defined spots appear superimposed on a background of the diffuse reflexions. After an interval of eleven days the intensity and size of the individual reflexion spots increase, and after twenty-four days the diffraction rings are beginning to become discontinuous and tend to break up into individual spots.

The presence of very small amounts of impurities is known to exert an appreciable influence on the atomic rearrangement necessary for self-recovery and recrystallization to occur. Some years ago, other investigators[4,5] used X-rays to study the time of recrystallization at room temperature of two different samples of electrolytic copper in the form of cold-rolled sheets. The copper used in our work contained metallic impurities totalling 0·0055 per cent, but we also made some observations on a sample of copper containing 0 0249 per cent of metallic impurities. Here again self-recovery was detected, but the extent of the change was less after one year than the purer specimen had shown after six days.

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Behaviour of Hypochlorite and of N-Chloroamines at the Dropping Mercury Electrode

ALTHOUGH Marks and Glass[1] have carried out amperometric titrations using a stationary gold electrode as the polarizable cathode, no results of investigations concerning the behaviour of hypochlorite and of N-chloroamines at the dropping mercury electrode have been recorded.

In investigating methods of distinguishing between hypochlorites and N-chloroamines in aqueous solution, it has now been established that the hypochlorite ion is one of the oxygen-containing anions[2] which are irreversibly reducible at the dropping mercury electrode Solutions of sodium hypochlorite and of chloramine-*T* (sodium N-chloro-*p*-toluenesulphonamide) have been found to be reducible at *p*H values between 3·6 and 11·0 and at concentrations between 0·001 and 0·01 *N*. The half-wave potentials of neutral solutions in 0·5 *N*. potassium sulphate at room temperature are about + 0·08 V. and − 0·13 V. for solutions of hypochlorite and chloramine-*T* respectively, referred to the saturated calomel electrode.

The diffusion currents are proportional to the concentrations and are independent of the *p*H value. The irreversible electro-reduction of each compound involves two electrons per molecule.

The reduction of these two compounds by arsenite was investigated by current-time curves at a potential of − 0·75 V. (sat. calomel electrode). Hypochlorite is rapidly reduced at all *p*H values in the above range, whereas chloramine-*T* is reduced slowly, the rate increasing with diminishing *p*H value, becoming rapid in the presence of iodide. The estimation of hypochlorite in the presence of chloramine-*T* is possible at *p*H 11·0 owing to the great difference in the rates of reduction of the two compounds by arsenite.

The polarographic investigation of the reaction products of sodium hypochlorite, in concentrations varying from 0·008 to 0·020 *N*, and ammonium chloride showed: (*a*) using a deficiency of ammonium chloride, that ammonia is almost completely oxidized in alkaline solution and that N-chloroamines are formed in neutral or weakly acid solutions; (*b*) using an excess of ammonium chloride, that the monochloramine, formed at *p*H 6·8–11·0[3], is reducible at the dropping mercury electrode; its half-wave potential is about − 0·65 V. (sat. calomel electrode) in *N* potassium chloride solution at room temperature; the electro-reduction is irreversible and involves two electrons per molecule; dichloramine, formed at *p*H 5·0[3], is not reduced at the dropping mercury electrode under the conditions investigated, trichloramine, present at *p*H 3 6[3], appears to be reduced at about the half-wave potential of hypochlorite; the reduction of mono- and trichloramine by arsenite is slow, becoming rapid when activated by the presence of iodide.

A detailed account of this and similar work will be published later.

We wish to thank Messrs. Milton Antiseptic, Ltd, for their interest and support

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Volume Flow of Plastic Materials

SWAINGER[1] has stated recently that an increase in volume occurs during the plastic flow of duralumin specimens under a tensile test. While it is generally assumed that volume is unchanged during plastic flow, we should like to point out that, in 1939, Glanville and Thomas[2] showed that the creep of concrete in compression was characterized by a decrease in volume. The concrete, in fact, flowed into its own voids.

The reverse of this effect has now been observed in specimens of asphalt (consisting of a mixture of fine aggregate with tar or bitumen binder) when subjected to a simple constant-load tensile test. A specimen which showed a total linear extension of 7 per cent before breaking was found to show at the same time a volume increase of about 2 per cent. The volume-change occurred at a roughly constant rate from the moment of application of the load. After breakage, the fractured surface had a rough appearance, in striking contrast to the smooth appearance of a fractured surface broken under impact. It is evident that rupture occurring as a result of plastic flow in tension is due to the progressive weakening of the structure caused by steady dilatation of the material.

It is hoped to publish later a detailed account of this phenomenon as exhibited by bituminous road materials.

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Catatorulin Effect of Aneurin Disulphide

ANEURIN disulphide[1], formed by opening of the thiazole ring and oxidation to the —S—S— form, does not give the thiochrome reaction, unless suitably reduced by cysteine; it was reported to have some 60 per cent of the biological activity of aneurin, when given orally to animals. I have found in catatorulin tests, by methods previously described[2], with the deficient pigeon brain that it is at least as active as aneurin (Table 1).

TABLE 1. CATATORULIN TEST WITH BREI, FROM AVITAMINOUS PIGEON BRAIN. SUBSTRATE, SODIUM PYRUVATE

Oxygen uptake μl/gm /hr. for respiration period 30–120 min.

		Change
No addition	733	—
Aneurin, 0 5 γ	1352	+ 619
Aneurin, 0 25 γ	1122	+ 389
Aneurin disulphide, 0 5 γ	1524	+ 791

TABLE 2. REACTIVATION OF OXIDIZED COCARBOXYLASE FOR CARBON DIOXIDE PRODUCTION. $\mu l CO_2$ PRODUCED IN 15 MIN. FROM SODIUM PYRUVATE IN PRESENCE OF ALKALINE WASHED YEAST, ANEURIN AND MAGNESIUM 28° C.

Addition	$\mu l CO_2$
Nil	31
+ Cysteine, 4 mgm.	48
Aneurin disulp pyrophos (1 5 γ)	35
,, ,, ,, + cysteine, 2 mgm	255
,, ,, ,, + cysteine, 4 mgm	311
,, ,, ,, + cysteine, 10 mgm	348
,, ,, ,, + glutathione 4 mgm	197
,, ,, ,, + B.A.L., 1 mgm	226
,, ,, ,, + cysteine-ester, 4 mgm.	91

I have also found that preparations of aneurin disulphide pyrophosphate made by the method of K. Myrback, I. Vallin and I. Magnell[3] by oxidation of cocarboxylase with iodine, when tested by the method of Ochoa and Peters[4] show little or no activity in the decarboxylation of pyruvate by washed yeast; this has been also stated recently by P. Karrer and M. Viscontini[5], so that I can confirm it independently. I have also found that —SH compounds reactivate the preparation for carbon dioxide production, when added immediately after the washed yeast (Table 2); 6 mgm. cysteine hydrochloride per respiration bottle produces a maximum effect (22 mM.); cystine was practically without effect. Myrback *et al.* treated their preparations of aneurin disulphide pyrophosphate with cysteine to reactivate for the thiochrome reaction. As judged by reactivation with cysteine for decarboxylation and restoration of the thiochrome reaction, most of my preparations of this substance were relatively inactive, showing not more than about 10 per cent of the original activity. Upon this basis, catatorulin tests with the dispersion from the avitaminous brain showed an activity corresponding to the amount of aneurin disulphide pyrophosphate present. Since the latter is itself inactive in the yeast test, it is logical to think that it must first be reduced to aneurin before it is active in the catatorulin tests by the —SH compounds present. The fact, however, that *in vitro* these brain enzyme preparations can carry out this change appears still to leave room for the suggestion of Williams and Zima that the —S—S— form of aneurin may play its part in the dehydrogenation.

Synthetic preparations of cocarboxylase (as used here) have been found in this laboratory to give some 60 per cent of the full effect of Lohman and Schuster's cocarboxylase[6]; one possible reason for this is the presence of some oxidized cocarboxylase; since this would be reactivated by cysteine, it is interesting to note that the addition of cysteine to our control synthetic cocarboxylase gives increases of approximately 50 per cent in the carbon dioxide production over the first 10-min. period. L. D Greenberg and J. F Rinehart[7] reported an activation of cocarboxylase tests by cysteine.

I am indebted to Messrs Merck and Hofman le Roche for specimens of cocarboxylase and to the latter for the aneurin disulphide I am also grateful to R. W. Wakelin for assistance with the tests.

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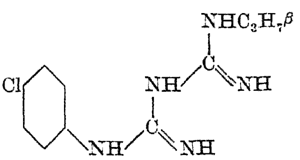
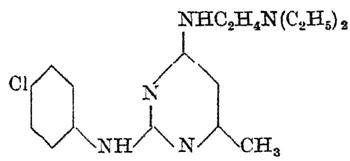
A Possible Mode of Action of 'Paludrine'

IN the evolution of the antimalarial drug 'Paludrine', the diguanide system was selected because it provided structural features similar to those found in the earlier active pyrimidine compound '2666'[1]. The biochemistry of the former drug, together with the results obtained in both experimental and clinical therapy, indicate, however, that it is biologically distinct from the prototype molecule Thus, for example, therapeutic potency is many times greater, and is apparent not only against the erythrocytic but also against the exo-erythrocytic forms of the malaria parasite. Further, 'Paludrine' does not show the antagonism for riboflavine exhibited by '2666' (and mepacrine) with respect to the growth of the *Lactobacillus casei*, an effect that we associate with the formal structural resemblance of the latter drugs to the vitamin, and which may also be connected with their parasiticidal activity.

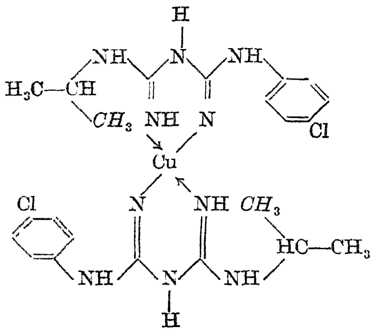


'Paludrine'

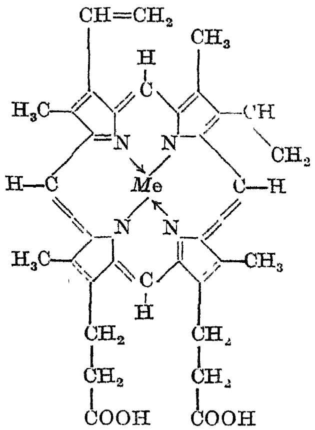


'2666'

So far, the biochemical and biological researches of our colleagues, Drs. Madinaveita and Davey, have not provided any explanation for these facts. We now suggest, on the basis of certain chemical observations, that the antimalarial activity of 'Paludrine' may be connected in some way with an interference with the porphyrin metabolism or enzyme systems of the parasite. 'Paludrine' forms a copper derivative the analysis of which gives one atom of copper combined with two molecules of the drug. Assuming a symmetrical disposition of the diguanide molecules in a planar structure (compare phthalocyanine), space models indicate the arrangement formulated below. The methyl groups printed in italic type are accommodated either above or below the general plane of the complex, and are therefore separated from the adjacent imino groups by a distance considerably greater than that apparent in the diagram. We were at once struck by the similarity of the copper complex so formulated to the naturally occurring porphyrin pigments. For comparison, the structure of a metal protoporphyrin is given. The correspondence between the six-membered rings chelating the metal in both systems is apparent, as is also the simulation of the pyrrole rings of the porphyrin by the folding of the anilino- and isopropylamino-groups of the drug complex. In addition, the isopropyl group, which gives maximum antimalarial activity in the diguanide series, provides side-chain methyl groups corresponding with the 1 : 5-dimethyl groups common to all the known natural porphyrins.



Copper complex of 'Paludrine'



Metal protoporphyrin

While consideration of the copper complex of the drug led to the recognition of these points of resemblance, this metal need not necessarily be that implicated in the postulated biological interference of the drug with the malaria parasite. Indeed, even in the absence of a metal atom, the probability of hydrogen bonding between N_2 and N_4 would cause the molecule to retain some of the structural features of the metal complexes. Finally, it should be remarked that the low toxicity of 'Paludrine' to the animal organism, and its general inactivity against a wide range of other micro-organisms, implies that the postulated antagonism relates to a porphyrin system highly specific to the malaria parasite, so that biochemical proof or disproof of the hypothesis will not readily be forthcoming.

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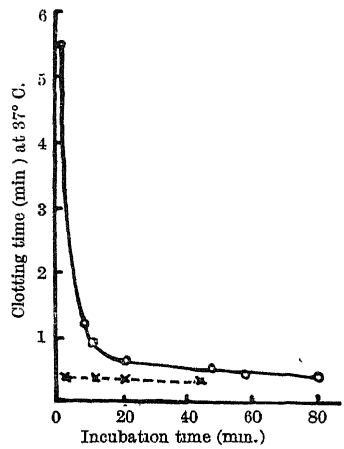
Acceleration of Thrombin Formation by a Plasma Component

According to Quick[1], prothrombin is composed of two components *A* and *B*, in combination with calcium. Nolf[2] carried out experiments from which he formed a similar conclusion. On the other hand, Seegers, Loomis and Vandenbelt[3] used purified preparations and concluded that prothrombin consists of a single substance which can act as thrombin precursor.

Determination of prothrombin activity is usually based on the estimation of plasma coagulation time. A method for the determination of actual prothrombin concentration in relation to plasma coagulation time has been developed in this laboratory (Fantl and Nance[4]). It is based on the observation that barium carbonate has the property of preferentially adsorbing prothrombin, together with minimal amounts of other plasma constituents. Prothrombin is estimated as protein in the adsorbate. It was found that the prothrombin concentration in normal human oxalated plasma averaged approximately 2 mgm. per 100 ml. when expressed as protein nitrogen. This result is in good agreement with a calculation of the prothrombin concentration based on the two-stage technique of Warner, Brinkhous and Smith[5] as carried out by Seegers, Loomis and Vandenbelt[3]. Since the barium carbonate technique gives a lower value for protein per unit of prothrombin than any other procedure, it should be possible to test the conflicting views regarding prothrombin constitution.

Elution of prothrombin from the adsorbate was carried out at *p*H 6, and dialysis in the cold yielded a solution which has been tested for prothrombin activity by incubating it with a variety of thromboplastins (homologous and heterologous brain extracts and Russell viper venom) and calcium ions. The resulting thrombin was added to a purified fibrinogen preparation in the range of *p*H 6·0–7·2. The results of a typical experiment are recorded graphically.



THROMBIN FORMATION FROM ISOLATED PROTHROMBIN:
— o —, assay with fibrinogen *p*H 7·2, incubation at 19° C.
— x —, „ „ prothrombin-free plasma

As can be seen from the graph (continuous line) such a system is active in inducing fibrin formation. However, the reaction-rate of thrombin formation is slow. Preliminary incubation of prothrombin and thromboplastin for approximately an hour yields maximal activity, which remains constant for several hours. When prothrombin concentrations are plotted on a log scale against incubation times on a decimal scale, a straight line is obtained until 60 per cent of the prothrombin has been converted into thrombin. This suggests that during the early stages the reaction proceeds according to the laws of a reaction of the first order. From these results it is obvious that prothrombin isolated from human plasma is the only precursor of thrombin.

It was found possible to accelerate the thrombin formation in the above system when purified fibrinogen was replaced by plasma from which prothrombin had been completely removed by adsorption. Here maximal activity was reached after a considerably shorter incubation time (broken line). Thus it appears that normal plasma coagulation depends not only on an adequate concentration of prothrombin but also on the presence of an accelerator.

A detailed account of the results will be given elsewhere.

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Aspergillin: a Name Misapplied to Several Different Antibiotics

The name 'aspergillin' has been applied to at least four different antibiotic substances from species of *Aspergillus*. Bush and Goth used the name at first[1] for a compound from *A. flavus* which they later named flavicin[2], and which, when investigated by Fried and co-workers[3] under the name of flavicidin, ultimately appeared to be a double-bonded isomer of penicillin *F*.

Stanley[4] applied the name 'aspergillin' to a crystalline compound from a strain of *Aspergillus* the specific name of which is not given. The compound melted at 272–280° C., contained sulphur, and showed bacteriostatic activity against twelve species of pathogenic bacteria, both Gram-positive and Gram-negative. From Stanley's brief description, his compound appears to differ from previously described sulphur-containing antibiotic compounds.

Soltys[5] referred to a filtrate from *A. fumigatus* (No. 367 of the National Collection of Type Cultures) as 'aspergillin'. It was bacteriostatic against *Mycobacterium tuberculosis* and *M. phlei*, but not against two strains of staphylococci. It is not yet clear whether it is really a new antibiotic material.

More recently, Krasilnikov and Korenyako[6] reported that certain strains of *A. niger* produced an alcohol-soluble antibiotic substance, active against both Gram-positive and Gram-negative bacteria, and stable upon heating or prolonged storage. It was not obtained in crystalline form. They differentiated it from a number of known antibiotic compounds, but unfortunately did not differentiate it specifically from clavacin and aspergillic acid. They, too, gave their active factor the name of 'aspergillin'.

The application of the name 'aspergillin' to four different antibiotic substances might in itself lead to some confusion. However, further confusion arises from the fact that the name 'aspergillin' was originally proposed by Linossier[7] in 1891 for the black, water-insoluble pigment of the spores of *A. niger*. So far as is known, this pigment has never been tested to determine whether or not it possesses any antibiotic activity. However, it has been repeatedly studied under the name of 'aspergillin'[7–12] and has been characterized as a humic acid[11].

Accordingly, it would seem desirable to restrict the use of the name 'aspergillin' to the black pigment of the spores of *A. niger*. The antibiotic of Bush and Goth has already been renamed. If the antibiotics of Stanley, of Soltys, and of Krasilnikov and Korenyako prove to be different from any previously described, new names should be selected for them. It is to be hoped that, in the future, investigators of antibiotic substances will avoid applying the name 'aspergillin' to their materials, in order to avoid useless and troublesome synonyms and to prevent further confusion in the literature.

In a very recent paper[13], it is reported that Stanley's 'aspergillin' is similar to, if not identical with, gliotoxin. If this antibiotic is finally definitely identified as gliotoxin, the necessity for a new name will be eliminated.

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Synergic Action of Penicillin and Bacteriostatic Dyes

Synergistic action of penicillin with other drugs capable of assisting the defence mechanisms of the body against bacterial pathogens has been reported by a number of workers[1–6]. Basic dyes like brilliant green, methylene blue, acriflavine and gentian violet are well known to possess antiseptic properties, and indeed some of them are used in the cure of wound infections. Thatcher[7] has demonstrated a pronounced synergistic effect *in vitro* between sulphanilamide drugs and dyes on Gram-negative bacteria. Though the average therapeutic dose of penicillin now used is sufficient to maintain a higher concentration than is actually necessary to inhibit a particular organism in the blood stream, the fact that there may still be very resistant organisms in certain sites, and also that sufficient penicillin may not reach certain massive infections in localized areas, make it desirable to use a combination of bacteriostatic substances. As the available evidence would suggest that penicillin and the dyes act on bacteria in different ways, it was hoped that the combined action of these would be one of mutual reinforcement or potentiation In this note we record the results of *in vitro* studies on the bacteriostatic action of penicillin when alone and when combined with bacteriostatic dyes on typical Gram-positive and Gram-negative bacteria

The experiments were designed to estimate the minimum amount of penicillin which would completely inhibit the growth of the test organisms in plain broth and in broth containing varying concentrations of the dyes. Sterile culture tubes containing different concentrations of bacteriostatic agents under investigation were inoculated with one loopful of a 24-hour culture. The growth was normally observed after 24 hours of incubation at 37° C. The minimum bacteriostatic concentration recorded in the accompanying tables was the lowest concentration of penicillin or dye showing no visible growth.

TABLE 1

Organisms ($1·5\times10^6$ cells)	Minimum inhibiting concentration of Penicillin	Brilliant green	Methylene blue	Gentian violet
Staphylococcus aureus	0·015 units/c.c	$1·75\times10^{-6}$	2×10^{-4}	$1·5\times10^{-6}$
Escherichia coli	Complete inhibition not apparent even with 15·0 units per c c.	1×10^{-6}	Complete inhibition not apparent at even saturation level	6×10^{-4}

TABLE 2

Organisms ($1·5\times10^6$ cells)	Minimum inhibiting concentration of dyes in the presence of penicillin: Brilliant green	Methylene blue	Gentian violet
Staphylococcus aureus 0·01 units/c.c. of penicillin	2×10^{-6}	2×10^{-4}	2×10^{-6}
Escherichia coli 14·0 units/c.c. of penicillin	$1·25\times10^{-6}$	No inhibition even with concentrated solutions	$7·5\times10^{-4}$

The results show that the presence of bacteriostatic dyes helps to reduce the concentration of penicillin required for the inhibition of the growth of the organisms. The increased potentiating effects of the dyes may be due to the synergic action of the individual drugs on the organisms, or less probably to a chemical reaction between the bacteriostatic agents forming a complex with greater bacteriostatic action. The unsatisfactory action of methylene blue tends to suggest that such complexes are probably formed. The precise degree of enhancement of the bacteriostatic action seems to vary with the dye and upon the dye sensitivity of the organisms. It has also been ascertained by separate tests that it depends on the number of organisms present, the strain specificity of the susceptible species and environmental conditions.

Studies on the synergic action of penicillin and other dyes, as also on the bacteriostatic action on other organisms, and the *in vivo* aspects of the problem, are in progress.

Our grateful thanks are due to Prof. V. Subrahmanyan and Drs. K. P. Menon and N. N. De for their interest and helpful criticisms, and to the Council of Scientific and Industrial Research, under the auspices of which this work was undertaken.

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Function of Prostatic Phosphatase

IN human semen large amounts of a phosphatase with acid pH optimum originating from the prostate has been demonstrated by Kutscher and Wolbergs[1]. The phosphatase activity of semen in optimal conditions amounts to several thousand times the activity of the alkaline phosphatase in serum. No explanation as to the function of this enzyme has so far been advanced.

When the very large amounts of inorganic phosphorus found in human semen (*c.* 100 mgm./100 ml) is considered, it was an obvious possibility that this inorganic phosphorus might have arisen through the breakdown of some organic phosphorus compound under the influence of the prostatic phosphatase. When semen was examined immediately after ejaculation, it was, in fact, found that the concentration of inorganic phosphate is quite low, and it rapidly increased during the first few minutes. If ejaculation is performed directly in ice-cold trichloroacetic acid, the amount of inorganic P is only about 10 mgm. per 100 ml., whereas the total acid-soluble P amounts to 90–120 mgm. per 100 ml.

The nature of the phosphorus compound thus revealed was investigated by fractionation of the barium salts in the usual way. It was found that by far the greater part of the organic P (60–70 per cent) was present as an alcohol-soluble compound. In living tissue only two phosphorus compounds with this property have been described, namely, the sphingosine choline phosphate of Booth[2], and choline glycerophosphate found in autolysed pancreas by Schmidt, Hershman and Thannhauser[3].

Practically all the phosphorus compound could be precipitated from 90 per cent alcohol by alcoholic mercury chloride. The substance when purified by two or three such precipitations gave a P : N ratio of 1 : 1, thus excluding sphingosine choline phosphate. Hydrolysis showed that it is extremely stable. Boiling with $5N$ sulphuric acid for two hours only split off about 15 per cent of the phosphorus, and treatment with strong alkali produced a very slow destruction accompanied by liberation of trimethylamine. Choline glycerophosphate very easily splits off choline on treatment with acids and even cadmium chloride. That was not the case with the present compound.

On treatment with prostatic secretion (obtained by digital massage) the substance was split quantitatively into inorganic phosphate and choline. That a third substance should arise during splitting is scarcely probable, since the great stability towards hydrolysing agents strongly indicates a primary phosphorus compound. The properties of synthetic phosphoryl choline have been studied by several investigators[4,5,6], and agree well with the properties of the substance in semen, although the barium salt has been claimed to be precipitated by one volume of alcohol[4]. This was, however, found to be the case only in rather concentrated solution.

Phosphoryl choline has been demonstrated in beef liver[7]; but only 0·2 gm. of the picrate was isolated from 200 kgm. of liver. It was quite possibly formed from lecithin during the rather drastic isolation procedure.

It has been shown that by far the greater part of the semen phosphorus originates from the seminal vesicles[8]. It must therefore be assumed that phosphoryl choline is formed in this organ. During and after ejaculation, the secretion from the seminal vesicles comes in contact with prostatic secretion, whereby choline and inorganic phosphate are formed. Nothing is known as yet concerning the possible physiological function of choline or phosphate (or both).

Semen from bulls does not contain excessive amounts of phosphatase, and the concentration of choline in one-day-old samples was found to be only about 30 mgm. per 100 ml., thus perhaps indicating that the splitting of phosphoryl choline is the sole function of prostatic phosphatase.

The quantity of choline found in samples of semen from normal men amounts to 250–400 mgm. per 100 ml. This is of interest in connexion with the Florence test (formation of characteristic crystals with potassium tri-iodide) used in legal medicine for the detection of sperm stains. It is generally recognized that this reaction is due to choline, and it has been assumed that the choline responsible was formed through decomposition of lecithin. If this is the case, semen should contain more than ten times the amount of lecithin actually found.

A detailed account of the present work will be published elsewhere.

FRANK LUNDQUIST
Institute of Legal Medicine,
University of Copenhagen.
Oct. 11.

[1] Kutscher, W., and Wolbergs, H., *Z. physiol. Chem.*, 236, 237 (1935).
[2] Booth, F. J., *Biochem. J.*, 29, 2071 (1935).
[3] Schmidt, G., Hershman, B., and Thannhauser, S. J., *J. Biol. Chem.*, 161, 523 (1945).
[4] Plimmer, R. H. A., and Burch, W. J. N., *Biochem. J.*, 31, 398 (1937).
[5] Baer, E., and McArthur, C. S., *J. Biol. Chem.*, 154, 451 (1944)
[6] Riley, R. F., *J. Amer. Chem. Soc.*, 66, 512 (1944).
[7] Inukai, F., and Nakahara, W., *Proc. Imp. Acad. Tokyo*, 11, 260 (1935)
[8] Huggins, C. B., and Johnson, A. A., *Amer. J. Physiol.*, 103, 574 (1933).

Primary Carcinoma of the Liver in the Duck

Fig 1. CHOLANGIOCELLULAR CARCINOMA OF LIVER. KHAKI-CAMPBELL DUCK

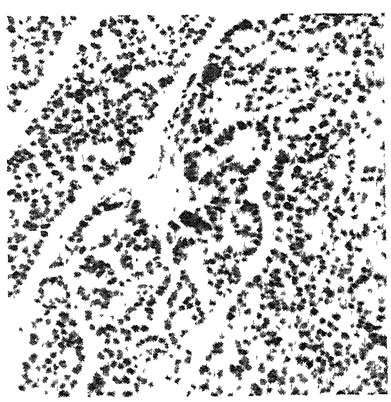


Fig. 2 HEPATOCELLULAR CARCINOMA, × 180 KHAKI-CAMPBELL DUCK

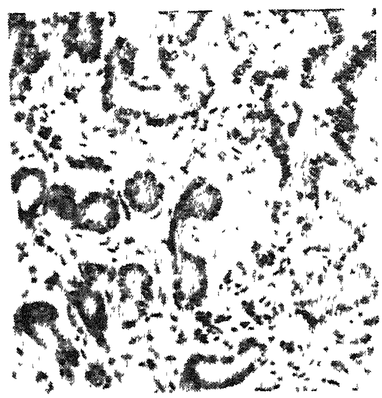


Fig. 3. CHOLANGIOCELLULAR CARCINOMA, × 180. AYLESBURY DUCK

IN recent months, several cases of primary carcinoma of the liver of ducks have been observed. A survey of the relevant literature has not brought to light any mention of this condition in ducks, which may thus possibly be a new disease, hitherto unreported.

To date, eleven cases have been encountered, some having been diagnosed in life. Comparatively few ducks come to this laboratory for post-mortem examination, as may be judged by the fact that only forty-nine ducks were examined in the period 1944–46. Yet in this period eleven cases were observed, or a relative incidence of 22·5 per cent. The comparable figures for the preceding four years are twenty-one ducks examined and no tumours observed.

The liver in such cases is enlarged, and contains multiple discrete green tumours. Metastases have been observed in the kidney and ovary. Histologically, these tumours are seen to be either hepatocellular carcinomata, or cholangiocellular carcinomata (see photographs). In one instance the two types occurred in the same case.

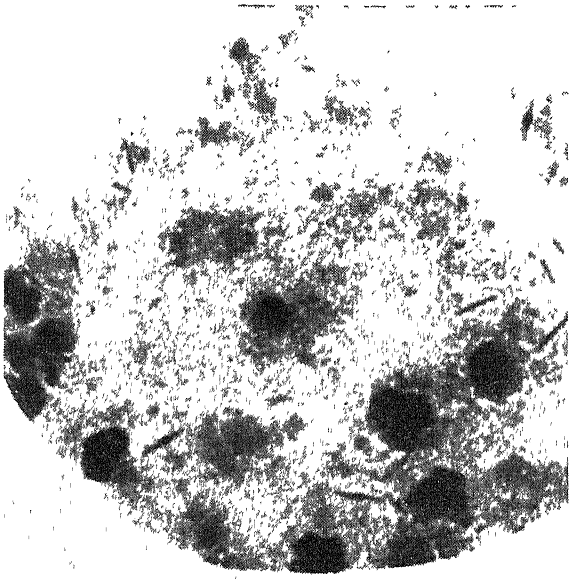
Of these eleven cases, three birds came at comparatively short intervals from one small flock, and three other cases occurred in another small flock. Inquiry revealed that in the first instance the three ducks were all originally obtained from the same poultry farm, and were of related stock; but in the second instance the three affected birds originated from different farms and different stock. This latter observation seems to render unlikely the possibility of a hereditary factor, and tends to favour the hypothesis of an infectious disease of a neoplastic nature. All that can be said at the moment in support of a virus hypothesis is that so far it has been found impossible to cultivate this tumour in the yolk sac of fertile hen eggs, as inoculation causes a 100 per cent embryo mortality. It is hoped to carry out transmission experiments as, and when, further suitable material becomes available.

J. G. CAMPBELL

Department of Poultry Diseases,
Royal (Dick) Veterinary College,
Edinburgh. Oct. 11.

Morphological Changes in *Bacillus fusiformis*

IN a communication in *Nature*[1], Webster and Frey have reported changes in the morphology of the *Bacillus fusiformis* found in cases of ulcerative gingivitis after the application of penicillin. The organisms had developed central round or spindle-shaped swellings. In an investigation of tropical



FUSIFORM BACILLI WITH CENTRAL SWELLING; SMEARS FROM UNTREATED TROPICAL SORES. × c. 900

ulcer in Madras, I have, however, noted in smears from untreated cases similar changes in the morphology of the fusiform bacillus. The central swelling is seen both by dark-ground illumination and after staining. It would appear, therefore, that the changes in morphology are due to the influence of other factors besides any specific treatment.

N. SESHADRINATHAN

King Institute, Guindy,
Saidapet Post, India.
Aug. 26.

[1] Webster, J. F., and Frey, H., *Nature*, **158**, 59 (1946).

Fusarium oxysporum on the Oil Palm

IN an earlier communication[1] I directed attention to the presence of a vascular wilt disease of the oil palm (*Elæis guineensis*) in the Belgian Congo. In so far as mycological studies could be pursued under the conditions of the investigation, the same species of *Fusarium* was isolated on a number of occasions from discoloured vascular strands. A culture submitted to Dr. S. P. Wiltshire of the Imperial Mycological Institute has now been reported on by Dr. W. L. Gordon of the Dominion Laboratory of Plant Pathology, Winnipeg. The latter, who has been making a special study of this genus, has identified the culture as *Fusarium oxysporum* forma. The organism isolated from infected vascular strands of the oil palm is thus a strain or form of the comprehensive species to which the other wilt-producing *Fusaria* belong. Its pathogenicity has, of course, still to be tested.

A second culture of *Fusarium* was also submitted for identification. This was isolated from a characteristic leaf disease of the oil palm known in the Congo as patch yellow, certain genetical types of palm being apparently highly susceptible. This fungus has also been identified by Dr. Gordon as a form of *Fusarium oxysporum*. It closely resembles the first-mentioned strain, though differences are apparent on certain media. An interesting mycological and pathological situation thus awaits detailed investigation.

C. W. WARDLAW

Department of Cryptogamic Botany,
University of Manchester.
Oct. 21.

[1] Wardlaw, C W., *Nature*, **158**, 156 (1946).

Origin of the First European Potatoes and their Reaction to Length of Day

Mr. Hawkes and Mr. Driver[1] believe that the greatest single factor limiting the yield of Andean varieties under British conditions is the day-length requirement, thereby implying that they are, on the whole, good yielders in suitable conditions. This is not our experience, which is that many of them are thoroughly bad, even in short days. The point is material to our argument, and some experimental facts are called for.

Thirteen Andean varieties of *S. tuberosum* from the Empire Potato Collection were grown in winter, and compared with Up-to-Date in identical conditions. Seven (EPC 369, 501, 588, 595, 952, 1094 and 1144) gave less than one third of the yield of Up-to-Date, five of these giving less than one tenth. Only three (EPC 140, 355 and 1407) were in the same class as Up-to-Date, and No. 140 outyielded it. In another test during the fairly short days of the sub-tropical summer, results were worse. None of the seven poor varieties gave as much as one fifth of the yield of Up-to-Date, and only No. 140 was in the same class as the domestic variety. The winter tests were done out of doors at Pretoria (lat. 26° S., altitude 4,500 ft.). Because of the fairly high altitude, non-luminous heaters had to be used at night to give protection against light frosts. The day-length during winter in Pretoria varies from 10½ to 12 hours, but some lines grew a little beyond the vernal equinox into days slightly more than 12 hours long. The winters are sunny and almost cloudless, and in the amount of light Pretoria is similar to areas of slightly lower altitude where winter crops of potatoes are regularly grown. Disease was practically absent in this test. The summer tests were made in a potato-producing district near Pretoria. The altitude was 5,200 ft. and the latitude 26° S., at which the longest day is about 13¾ hours long. Most lines grew for a few weeks beyond the autumnal equinox into days of 11–12 hours, and all were infected with *Alternaria solani* at the end, though, on the whole, to a smaller extent than Up-to-Date. The choice of the thirteen lines was quite random—they happened to be the first available for testing out of doors—and there is no reason for believing the results to be atypical.

All available evidence considered, it seems fairly certain that there are among the varieties from the Andes some which are very good and also some which are very bad: The exact proportions of good and bad have not been determined, and do not concern us here. What matters is that the varieties are certainly variable and probably, on the average, less well bred and selected than the European. This is to be expected in the circumstances that new seedlings arise comparatively easily in the free-fruiting Andean varieties, that there does not seem to have been any conscious effort to breed new varieties[2], that mixed varieties are commonly cultivated, and that no selection is practised except perhaps in a reverse way by the eating of the large tubers and the planting of the small ones[3]. These circumstances must lower the general standard of varieties in any collection which aims at being fairly representative or complete.

It is therefore felt that the belief that poor yields of Andean varieties in Britain are caused in the main by the long days of summer, even when the growing-season includes weeks of short days in autumn, is charitable to the varieties, but still unproved.

That extreme intolerance of long days had to be removed before potatoes could become what they are in Europe to-day has never been disputed. Tolerance of long days is necessary for earliness, and, by comparison with the first European potatoes, all modern European varieties are early, especially in north-eastern Europe where, in the absence of a long frost-free autumn, earliness is a necessity. (This, as I hinted before[4], may explain why the potato did not go to the north-east for centuries.) But that the incomplete shift from autumn to summer tuber-growth has, by itself and apart from greater care in breeding and selection, improved yields in western Europe is still an assumption by European workers.

Because the opinions of Mr. Hawkes and Mr. Driver are held in such high regard, I am sorry to see that they have not dropped the name *S. andigenum*[1]. It seems fairly satisfactorily proved, both on grounds of photoperiodism[4] and morphology[5], that there is no question of more than one species among the cultivated tetraploid potatoes ; this being so, the statement of Mr. Hawkes and Mr. Driver[6] that type herbarium specimens and many rare documents need examination loses its point so far as the immediate problem of discarding invalid names is concerned. The name *S. andigenum* is new, but the hypothesis of the Andean origin of the potato is not. Linnæus gave the habitat of *S. tuberosum* as Peru, and twenty years ago botanists generally believed that the potato came from the Andes. One could slip back twenty years, and lose the name *S. andigenum* without great inconvenience.

J. E. VAN DER PLANK
Department of Agriculture, Pretoria.

[1] *Nature*, 158, 168 (1946).
[2] Salaman, R. N., *J. Roy. Hort. Soc.*, 62, 261 (1937).
[3] Hawkes, J. G., Pub. Imp Bur. Plant Breeding and Genetics (1944).
[4] *Nature*, 157, 503 (1946).
[5] Salaman, R. N., *J. Linn. Soc.*, 53, 1 (1946).
[6] *Nature*, 157, 591 (1946).

DR. VAN DER PLANK's experiments at Pretoria afford additional evidence for the view, which, incidentally, we have never disputed, that certain Andean potatoes yield better than others, even under short day, and that only the best of them will yield, even under those conditions, as well as the domestic potatoes of Great Britain. It seems fairly obvious that selection for yield with the early European potato should have picked out those genotypes combining both tolerance to long day-length and intrinsic capabilities for high yield.

We have mentioned more than once our agreement with the view, first stated by Dr. Bukasov[1], that the yielding capability of a variety is dependent both on its photoperiodic response and on its inherent yielding capacity ; but we have felt it necessary, and still do, to stress the importance of the photoperiodic response on yield.

It seems to us that in paragraph 4 of Dr. van der Plank's letter the significance of the short days at the end of the growing season in Great Britain is too greatly stressed by him. Many short-day Andean potatoes have not progressed far enough with their tuberization by the beginning of October ever to be able to catch up with those varieties more tolerant of longer days. The result with these varieties that do not begin to form their tubers until they get a 12-hour day is that, even if they are not cut off by frost, their growth is soon brought to a standstill and they therefore have no chance to complete their tuber formation owing to the low temperatures and low light intensity. We feel that perhaps Dr. van der Plank does not adequately realize the difference in temperature and light condition between a short autumnal day in Great Britain and a normal short day in his own latitudes.

Finally, on the nomenclature problem, we would respectfully ask Dr. van der Plank to tell us, since he considers it unnecessary to wait until something is published on the subject, how we are to distinguish botanically between the Andean potato (at present known as *Solanum andigenum*) and the Chilean one (known now as *S. tuberosum*). We agree that they are not specifically distinct, but are they to be classed as varieties, forms or subspecies, and what are they to be called ? For our part, we totally disagree with any precipitate attempt to modify or delete a validly accepted botanical name without due regard to the precepts laid down by the International Rules of Botanical Nomenclature, since what has once been published requires another refuting publication before it can be abolished. In this case, the adequate publication of the botanical type for *S. tuberosum* would be necessary, as we have already stated[2], and the naming and describing of the Andean and Chilean varieties (or subspecies) within its boundaries. Until that is done we feel that it is better to continue using the name *Solanum andigenum*.

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C. M. DRIVER
Imperial Bureau of Plant Breeding and Genetics,
School of Agriculture, Cambridge.

[1] Bukasov, S. M., Lenin Acad. Agric. Sci., Inst. Plant Ind., Leningrad (1933)
[2] *Nature*, 157, 591 (1946).

Testing the Difference between Two Means of Observations of Unequal Precision

I AM sorry my use of the word 'tolerable' should be a difficulty to Dr. Bartlett[1], but the explanation is really very simple.

In 1936[2] Bartlett, discussing what has come to be known as Behrens' problem, put forward a solution which, on examination, can be seen to be invalid on logical grounds. For example, if two boys are measured and found to differ in height by ½ in., and if two girls show exactly the same difference in their statures, Bartlett's test gave a probability of 50 per cent of inferring a highly significant sex difference in stature, and this whether the difference between the boys and the girls was great or small. I criticized the proposed test at the time and received from Bartlett the assurance that he would not think of using it in practice. It seemed that the matter was at an end.

Later, I understand that Dr. J. Neyman, sharing Bartlett's objection to Behrens' original solution of the problem, had advocated this proposal of Bartlett's. I could not, therefore, ignore its existence, and so did not say that no solution alternative to Behrens' had been put forward, but only that no tolerable alternative solution had so far been advanced, since the only alternative then available appeared to be manifestly inapplicable to real problems.

I am quite aware that Bartlett, following Neyman, feels bound to identify the populations of samples envisaged in tests of significance with those generated by repeated sampling of a fixed hypothetical population, and I do not expect him to change his opinion, although it appears to me to be logically fallacious. What I commented on, in view of the great confidence with which criticisms of Behrens' solution had been launched, was the long delay in putting forward an alternative solution satisfactory to the Neyman–Bartlett point of view with which that of Behrens could be compared. The fact that Bartlett can now announce a new solution by B. L. Welch which "appears to be exact, at least in the sense . . ." leaves us still some way to go before the two next necessary steps, namely, an examination of the logical basis of the new solution, and the numerical comparison of its consequences with the tables available for that of Dr. Behrens.

R. A. Fisher

Department of Genetics,
University of Cambridge.
Oct. 18.

[1] Bartlett, M. S., *Nature*, 158, 521 (1946).
[2] Bartlett, M. S., *Proc. Camb. Phil. Soc.*, 32, 560 (1936).

The Rutherford Papers in the Library of the Cavendish Laboratory

This material relating to the late Lord Rutherford was generously presented to the Cavendish Laboratory by Lady Rutherford in 1939, and is preserved in the Library. It has now been classified, and is of such great biographical and historical interest that we are giving a brief account of it here. It covers Rutherford's scientific career from his first research papers on "The Magnetisation of Iron by High-Frequency Discharges" (*Trans. N.Z. Institute*, 1894) to his last contribution in *Nature* of August, 1937 on "The Search for the Isotopes of Hydrogen and Helium of Mass 3".

One set of letters represents correspondence over many years with scientific men such as B. B. Boltwood, N. Bohr, W. H. Bragg, H. Geiger, O. Hahn, S. Meyer, F. Soddy, Madame Curie, H. Moseley and J. J. Thomson. They afford a fascinating study of the development of radioactivity and nuclear physics, and are interesting because they reveal the way these men were thinking at the time the letters were written. In another set there are letters from his pupils, such as J. D. Cockcroft, J. Chadwick, H. Robinson and P. Kapitza, and other letters which he kept for their especial interest.

Among the biographical material are his letter of application and testimonials for the chair at McGill, and correspondence about the Manchester and Cavendish appointments. There is also a short autobiographical note written in 1930, and some of his "Lists of Projected Researches" which he drew up each year.

There are his manuscript sheets of "Radioactive Substances" and the "Radiations from Radioactive Substances", his notes for his Royal Institution lectures between 1921 and 1937 and many popular lectures and addresses. The collection also includes many of his experimental notebooks. Newspaper cuttings cover the whole of his career from 1897 to 1937. Among the items of historical interest one deserves special mention—J. J. Thomson's original letter accepting Rutherford as a research student in the Cavendish.

Future historians of science will find in the collection a rich mine of information, not only about Rutherford himself but also about many famous men of his time.

Elizabeth B. Bond
W. L. Bragg

Cavendish Laboratory, Cambridge.

The Illustrations of the Australopithecinæ

In *Nature* of June 29, p. 863, there appeared a very appreciative review by Prof. W. E. Le Gros Clark of the recent book on the South African fossil ape-men, by Dr. G. W. H. Schepers and myself. There is only one minor point on which I should wish to comment. The reviewer says : "The illustrations, too, while they give a good general impression of the bones, are not sufficiently accurate for comparative studies. For example, the text-figure of the *Paranthropus* talus, although stated to be natural size, actually represents the bone as somewhat larger than the cast". The reviewer has assumed that the discrepancy is due to the illustrations being inaccurate. Here he is in error. All the drawings of teeth and bones are, I think, accurate to a millimetre, and most to a fraction of a millimetre. The discrepancy complained of is due to the inaccuracy of the cast.

The ankle bone was found in 1943. It was war-time. Our preparator was in North Africa with the army. The discovery was so important that I thought I would attempt to make some casts with latex, and send them to some of the leading anatomists. Unfortunately, owing to shrinking of the latex, the casts, though they give an excellent idea of the shape, are a little smaller than the specimen. It was probably unwise to attempt what I could not do with complete success.

R. Broom

Transvaal Museum, Pretoria.
Sept. 16.

I much regret that, by my assumption that the cast of the talus which Dr. Broom so generously distributed was accurate, I was led to question the accuracy of certain of his illustrations of the Australopithecine material in his recent monograph. Dr. Broom's reference to the slight shrinkage of some of the latex casts (which were produced under exceptionally difficult war-time conditions) explains clearly how this misunderstanding arose.

W. E. Le Gros Clark

RESEARCH ITEMS

Hybridization in Rana

J. H. Moore (*Proc. U.S. Nat. Acad. Sci.*, 32, 209; 1946) has shown that hybridization between populations of *Rana pipiens* show increasing numbers of embryonic defects as the latitudinal distance increases. On the other hand, hybrids between *Rana pipiens* and *R. palustris* do not show any signs of defect or of hybrid inviability. The two species occur sometimes in the same area, but despite the absence of an obvious isolating mechanism the two species keep separate in the wild.

Action of Choline Esters on a Brazilian Amphibian

H. Moussatché has published the results of studies on the action of certain choline esters on the rectus abdominalis muscle of some Brazilian amphibians (*Rev. Brasil Biol.*, 5, No. 4, Dec. 1945). A description of the apparatus employed is given and the results for the frog *Leptodactylus ocellatus* are tabulated. Sensitivity was apparent with a concentration of acetylcholine of the order 10^{-7}, and, while some choline esters showed nearly the same activity, others displayed considerably less. Experiments were conducted to investigate the influence of temperature on the extent of the contraction induced by the acetylcholine in the rectus abdominalis muscle of *L. ocellatus*, and it was found that this increased with the temperature.

Induction of Conjugations in *Paramecium*

T. T. Chen (*Proc. U.S. Nat. Acad. Sci.*, 31, 404; 1945) has found that fluid from the culture media of a Russian clone of *Paramecium bursaria* will cause clones of other varieties to become sticky, to clot and to conjugate, although the Russian clone will not itself conjugate with these clones. The conjugation thus induced is not similar to that between two diverse mating-type conjugants. Nuclear fusions have been observed in the induced conjugants. Nuclear changes were observed in a few solitary individuals. Some three other clones of these varieties did not react to the fluid from the Russian culture; there may be differential effects. The phenomena may be related in some way to those in Algæ found by Geitler and Moewus, in Protista by Kimball and in *Paramecium* by Sonneborn.

New Plant Diseases

Several new fungus diseases of plants have recently been described (*Trans. Brit. Mycol. Soc.*, 28, Parts 3 and 4, Nov. 1945). S. J. Hughes discusses the parasitism of *Pleospora herbarum* on sainfoin and on mangolds. *P. herbarum* and its conidial form, *Stemphylium botryosum*, can attack a variety of hosts, and its presence upon mangolds seems to give a severe disease, especially when the crop is grown on potash-deficient soils. A root-rot of *Cineraria* has been investigated by Moira C. D. Munro. This appears to be due mainly to *Phytophthora cinnamomi*, though *P. cambivora* is a less virulent parasite. *P. cinnamomi* has been isolated upon several types of media; it appears to be most active at temperatures between 16° and 30° C., and can grow over a fairly wide range of *p*H. An interesting occurrence of the potato blight fungus, *Phytophthora infestans*, on leaves and berries of a box thorn, *Lycium halimifolium*, is recorded by W. C. Moore. His description, however, does not suggest that this host may be an economic factor in increasing the spread of blight on potatoes. The same author also discusses briefly the appearance of *Alternaria radicina* as a seedling disease of celery, and the occurrence of a snow rot of wheat due to *Typhula graminum*. The latter appeared in Herts after a heavy fall of snow; the disease is known in Scandinavia, north Germany, the United States and Japan. Leaf spot of spinach caused by *Heterosporium variabile* appears to cause considerable damage on this plant. Ring rot of green walnut fruits, due to *Fusarium* sp., and scale spotting of tulip bulbs, the cause of which is uncertain, are also described.

Dual Drainage of Lakes

The apparent anomaly of two streams draining from the same lake, or dual drainage as he terms it, is discussed by E. C. Cabot in an article in the *Geographical Review* of July. Evidence is obtained from ground work but more generally from aerial photographs of Alaska, Labrador and Arctic Canada. He points out that a lake may change its outlet for a number of reasons, among which are ice retreat, ice blockage and stream piracy, and that as the shift of outlet occurs it may have dual drainage. Mr. Cabot discusses particularly the Great Bear Lake To the north the Hare Indian River, the original outlet in the deep gorge, drains to the Mackenzie. It is now partly abandoned and filled with lakes, but recently has reasserted itself and shows a continuous flow. To the south the second outlet is the broad and deep Great Bear River. The explanation lies in the movement of the Keewatin ice of the glacial period. On its final retreat the first outlet of the lake in front of the ice sheet was the Hare Indian River, but with further retreat a lower level in the rim of the lake was exposed and so the new channel functioned and the Great Bear valley was cut. But a considerable time was required before the original small trickle of this outlet was cut deep enough to lower the lake level below that of the original outlet, and the process is not entirely complete, especially in periods of heavy ice and snow melting.

Correlation Between Coronal Emission and Terrestrial Magnetism

Waldmeier and others have pointed out the extent to which intense emission from the solar corona accompanies large sunspots. A correlation between intense coronal emission and terrestrial magnetic disturbance may therefore be expected. During the War, Government-sponsored research was carried out in the United States to test whether this correlation could be used to forecast magnetic and ionospheric disturbances, and an account of the results has been given by A. H. Shapley and W. O. Roberts (*Astrophys. J.*, 103, 257; May 1946). Intense coronal emission is not a transient phenomenon, for it was found to persist often for several solar rotations; so when it was observed to appear at the east limb of the sun, a correlated magnetic disturbance might be expected a few days later. The correlation was so marked as to offer a very satisfactory means of forecasting. An unexpected feature of the results was that magnetic disturbances tended to reach their peak one or two days before the emitting coronal region reached the central meridian, whereas they occur one or two days after sunspots have crossed the same meridian. Alternative explanations offered for the difference between the results for corona and sunspots are a difference between the types of magnetic disturbance considered in connexion with the two, or a difference in longitude, amounting to about 40°, between sunspots and the accompanying coronal emission.

Surface Tension of Slightly Soluble Fatty Acids

THE surface properties of the intermediate acids with from seven to twelve carbon atoms per molecule have been studied by D. G. Douglas and C. A. MacKay (*Can. J. Res.*, 24, 8; 1946). The surface tensions of normal heptylic (C_7), pelargonic (C_9), capric (C_{10}) and lauric (C_{12}) acids above their melting points, and on aqueous solutions of heptylic, pelargonic, capric and undecyclic (C_{11}) acids at various concentrations, were measured. The capillary method of A. Ferguson and J. A. Hakes (*Proc. Phys. Soc.*, 41, 214; 1929) was used. It is shown that the surface tension of liquefied fatty acids depends on the length of the hydrocarbon chain, and that all the acids investigated have nearly the same temperature coefficient. It is indicated that the surface films require considerable time to become stable, the time depending on both the concentration and the length of the chain. From the surface tension isothermal for normal heptylic acid at 292° K., it is deduced that the surface film consists of a monolayer, each molecule occupying about 25 A. and oriented with its axis perpendicular to the surface.

Biotin

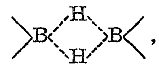
THREE papers by a number of authors working in the Merck Research Laboratories (*J. Amer. Chem. Soc.*, 67, 2096f; 1945) describe the synthesis and resolution of *dl*-biotin and its two stereoisomeric racemates *dl*-allobiotin and *dl-epi*-allobiotin. The starting materials were 4-benzamido-3-ketotetrahydrothiophene and γ-formylbutyrate. The resolution was carried out with the *d*-mandelic acid esters, and the *l*-arginine salts. Quinine methohydroxide was a satisfactory reagent for the separation of *l*-biotin. A stereochemical correlation of the three substances mentioned is described.

Liquid Racemic Compounds

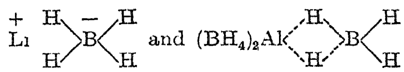
SINCE the work of Ladenburg on coniine, there has been much discussion as to whether racemic compounds of two optically active forms can exist in the liquid state, the solid forms being well known. Bawa Kartar Singh and Onkar Nath Perti (*Proc. Indian Acad. Sci.*, 22A, 170; 1945) have studied the solubility isotherm of camphor β-sulphonic acids at 335°. They present tables and curves which show that the solubilities of the *d*- and *l*-forms are identical, that the solubility curves of the *d*- and *dl*- and of *l*- and *dl*-forms are exact mirror images of one another, and that the shapes of the melting-point/composition and solubility/composition diagrams show that *dl*-camphor β-sulphonic acid has a large range of stability and exists in the fused and dissolved states. This result is of interest, since the evidence for the existence of racemic compounds in the liquid state is very meagre and the previous results are conflicting.

Structure of Electron-deficient Molecules

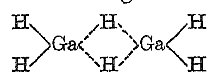
THE hydrogen bridge theory of the structure of diborane, B_2H_6, proposed by Bell and Longuet-Higgins (*J. Chem. Soc.*, 250; 1943), and extended by Pitzer (*J. Amer. Chem. Soc.*, 67, 1126; 1945) to the other known hydrides of boron, has been shown by Longuet-Higgins (*J. Chem. Soc.*, 139; 1946) to account for the properties of the borohydrides and the other covalent hydrides of elements in the first three groups of the Periodic Table. The theory assumes that the hydroborons are composed of smaller units (borines) of formula B_nH_{n+2} containing tervalent boron linked by hydrogen bridges:



that this polymerization continues until no free $>B-H$ groups are left except those adjacent to two bridges, and that hydroborons containing rings of fewer than five boron atoms are not stable. Pitzer introduced the conception of the hydrogen bridge linkage as a protonated double bond between boron atoms, represented as a σ bond, together with a π bond with two protons embedded in its antinodes. The borohydrides are now formulated as, for example:



and the covalent hydrides of metals formed by the action of atomic hydrogen on the metals are similarly formulated. The volatile gallium hydride is



and the indium and thallium compounds are similar. The non-volatile aluminium hydride $(AlH_3)_n$ is assumed to be a two-dimensional polymer with units joined by hydrogen bridges. The metal alkyls are also brought into consideration, although the data are scanty in this field. The paper is speculative but contains some interesting suggestions and provides a reasonable co-ordination of a number of compounds. In a paper by G. Silbiger and S. H. Bauer (*J. Amer. Chem. Soc.*, 68, 312; 1946) the electron diffraction results are said to rule out proton bridge structures for beryllium and aluminium borohydrides.

'Servo' Systems

ALTHOUGH systems of automatic control actuated by the difference, or 'error', between the actual and desired value of the quantity to be stabilized have been employed in electrical engineering for many years, war-time requirements have stimulated a rapid development of the subject and have led to the introduction of several new types of so-called servo systems. Little information about these developments has been published in Great Britain as yet, so that particular interest is attached to a paper by A. L. Whiteley (*J. Inst. Elec. Eng.*, 93, Part 2, No. 34, Aug. 1946) dealing with the theory of servo systems, with particular reference to stabilization. One of the major problems is that of achieving an adequate degree of stability, and the paper discusses the extent to which the latter is governed by response time-lags in the system and by the basic control characteristic of the servo. The addition of controlling signals proportional to the derivatives of error can theoretically produce stability. Since, however, such derivatives are seldom available, attention has been directed chiefly to the design of passive networks, which when placed at the input end of the servo give approximations to derivatives and/or integrals of error, so that the system performance is suitably modified, and to feed-back methods which achieve similar results and often possess important practical advantages. The paper is supplemented by several contributions to discussion and the author's reply.

ORIGIN OF RADIO-WAVES FROM THE SUN AND THE STARS

By Prof. M. N. SAHA, F.R.S.
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IT has been shown in a previous communication[1] that radio-waves of metre range cannot escape from the quiescent sun unless they originate in the corona, where the electron concentration falls to 10^6–10^8 per c.c. This seems to me to invalidate, at least in the case of the sun, the free free transition theory of the electron in the field of the proton, put forward by Henyey and Keenan[2] to explain the origin of 1-metre waves from regions of the Milky Way. For the corona is a purely 'electron atmosphere', where H-ions cannot exist in any considerable quantity without violating the laws of physics. Pawsey, Payne-Scott and McCready[3] do not consider it likely that these radiations can originate in any atomic or molecular process, but they suggest an origin in gross electrical disturbances, analogous to thunderstorms on the earth. Greenstein, Henyey and Keenan[4] in a note in *Nature* concede that the 1-metre waves emitted from the sun have probably a different origin than in the free free transitions of the electron in the field of the proton.

The object of the present note is to point out that the resources of atomic and molecular processes are not exhausted by the failure of the free free transition process. We have still another group of atomic (or rather nuclear) processes, which can give rise to the radio-waves emitted by the sun and the stars; and these processes are actually stimulated by strong magnetic fields of the type which are characteristic of an active sun. This is the process of excitation by a strong magnetic field of the energy-levels of the nuclei of atoms and molecules, which has been so beautifully demonstrated by the works of Rabi and his school, just before the War[5]. A brief description of the process is given here with the view of bringing out its potentiality for the explanation of the extremely interesting phenomenon of emission of radio-waves by stellar bodies.

The nuclei of many atoms, for example, H^1, Li^7, N^{14}, Al^{27}, Na^{23}, Mg^{25} (mostly isotopes with odd mass-number, D^2, Li^6, B^{10}, N^{10} being exceptions), possess spin, and finite magnetic moment of the order of $eh/4\pi Mc$, the so-called protonic magnetic moment, though actually the proton has a magnetic moment which is 2·7 times higher. In the absence of a magnetic field, the electron-cloud in the outer incomplete shells of the atom or the molecule react on the nucleus, and give rise to hyperfine structure of spectral lines. As a typical and well-investigated case let us take Na^{23}.

This nucleus has been shown to have a spin of 3/2 and a magnetic moment of 2 515 ($eh/4\pi Mc$ being taken as unit). In the normal state, the outermost $3s$-electron, which is in the $^2s_{1/2}$-state, causes a fine-structure of nuclear levels, characterized by the *hfs*-quantum number $f = |\, i + j\,|$, where i is nuclear quantum number, j is inner quantum number of optical level. For normal Na^{23}, $f = |\, \frac{3}{2} + \frac{1}{2}\,| = 2, 1$. The energy difference between the two nuclear levels has been very accurately measured by optical methods, and found to have the value 0·0592 cm.$^{-1}$ in frequency units. This has been confirmed independently[6].

Normal sodium atoms, say those contained in a sodium lamp, will have some nuclei in the stage $f = 2$, some in $f = 1$, and those in the state $f = 2$ are expected to emit spontaneously waves corresponding to the energy difference $\Delta\nu = 0{\cdot}0592$ cm.$^{-1}$, $\lambda = 17{\cdot}15$ cm., 1,773 Mc., the balance between the two states being restored by thermal exchange, but normally such transitions will be extremely rare We can scarcely expect emission of a single quantum from an excited nuclear level in 10^5 years.

But the conditions are entirely changed, as has been shown by Rabi and his co-workers, when the atoms are placed in a strong magnetic field, which is being crossed at right angles by a much smaller, but rapidly varying field, its period being comparable to those of the emitted radiation but not necessarily equal to these. What happens is roughly as follows under the action of the strong magnetic field, the atom takes up various orientations as in a Stern–Gerlach experiment, the energies of the orientations being as given below (formulæ 1 and 2). The varying field causes these orientations to change rapidly, and in this process, radio-frequency waves are emitted The energy values of the different orientations, however, change considerably with the field, but Rabi has calculated them from an extension of the theory of the Paschen–Back effect. The formulæ for Na^{23} are quoted :

Na^{23} : Nuclear spin $i = 3/2, f = 2, 1$.
m = magnetic quantum number
$= 2, 1, 0, -1, -2$ for $f = 2$
$= 1, 0, -1$ for $f = 1$.

ν_{2m} = energy in frequency units of a nucleus with $f = 2$, having the orientation 'm':

$$= -\frac{\Delta\nu}{8} + g(i)\,\mu_B H\cdot m + \frac{\Delta\nu}{2}\,(1 + mx + x^2)^{1/2} \qquad (1)$$

This holds for $m = 1, 0, -1$; for $m = 2$, the last term has the value $\frac{\Delta\nu\,(1 + x)}{2}$, for $m = -2$, the value $\frac{\Delta\nu}{2}\,(1 - x)$.

$\nu_{1,m}$ = energy in frequency units of a nucleus with $f = 1$, having the orientation 'm':

$$= -\frac{\Delta\nu}{8} + g(i)\,\mu_B.H.m - \frac{\Delta\nu}{2}\,(1 + mx + x^2)^{1/2} \qquad (2)$$

μ_B = Bohr-magnetron, $g(i)$ = Lande factor for nuclear magnetism $= \frac{m}{M}\mu_n/i$, where μ_n is the nuclear magnetic moment in terms of $eh/4\pi Mc$ as unit.

$\Delta\nu$ = separation between the two states in the absence of a magnetic field.

The number $x = \frac{\{g(j) - g(i)\}\,\mu_B H}{h\Delta\nu} = \frac{2\mu_B H}{h\Delta\nu} = \frac{H}{660}$ for Na^{23}. Curves of ν-values will be found in *Phys Rev.*, **57**, 769.

The transitions fall in two classes. One set, mostly consisting of those corresponding to $\Delta f = 0$, gives ν-values which vary from 0 at vanishing fields to the limiting value of $\Delta\nu/4$ for large fields. For a field of 660 gauss, the wave-lengths of the lines emitted are grouped round 1·36 metres, whereas for smaller fields, say 100 gauss, they may be as high as 4 metres. When the field is very large, the emission is grouped round $4 \times 17{\cdot}15 = 68{\cdot}60$ cm.

The second set, mostly consisting of radiations corresponding to $\Delta f = 1$, gives ν-values from $\Delta\nu$ to $x\Delta\nu$; these may give rise to centimetre waves; in fact, for $H = 10{,}000$ gauss, the emission is grouped round 1·1 cm.

These relations have indeed not yet been verified in emission, but in some ingenious absorption experiments by Rabi and his co-workers for Na^{23}, Li^6, Li^7, Cs^{133}, K^{41}; but there seems to be no reason why it should not be possible to design emission experiments, for example, by putting a sodium lamp in a strong magnetic field, which is then crossed by a feeble oscillating magnetic field at right angles. Such sodium lamp ought to give out strong radio-waves of both metre and centimetre range. It is desirable to carry out such experiments in view of the prospect which they hold out of throwing light on the all-important question of stimulation of transitions.

What we have said with respect to Na^{23} will also apply to the nuclei H, Li^6 and Li^7, B^{10}, B^{11}, N^{14}, Na^{23}, Al^{27}, and other nuclei which possess spin and magnetic moment, and therefore when forming part of an atom or molecule can exist in several well-defined quantized states produced by the electron cloud. The details of calculations will, however, widely differ, and cannot be given in this short communication; but as in the case of Na^{23}, they will give rise to both metre and centimetre waves.

The most important part in the sun and the stars will, however, be played, not by Na, but by hydrogen, because this forms, according to well-verified astrophysical arguments, 95 per cent of total number of atoms in the atmosphere of the sun; in the stars, also, hydrogen forms in the majority of cases more than 90 per cent of the atmosphere. Na was chosen simply to illustrate the phenomenon. In the spots, on account of lower temperature, the hydrides CH, MgH and SiH (and possibly H_2) are formed in great abundance, and their spectra form characteristic features of spots, but the greater proportion remains in the atomic state. For the H-atom, $\Delta\nu$ cannot be obtained from hyperfine structure experiments, but it has been calculated to have the value of $0{\cdot}0163\ \mu_p = 0{\cdot}0474$ cm.$^{-1}$, $\lambda = 21$ cm., $x = H/500$, and calculation shows that both centimetre and metre waves can be emitted by the H-atom, corresponding to $\Delta f = 0$, $\Delta f = 1$. But in the case of hydrides, N_2, CN, no experimental data or theoretical calculations are yet available; but it can be surmised that the characteristic radio-frequency waves would be much longer.

In addition to waves arising out of nuclear transitions, the rotational states of the molecules have also been shown by Rabi and his pupils to be capable of radio-frequency transitions in magnetic fields.

We consider next the possibility of nuclear emission of radio-waves of both centimetre and metre range from the sun and the stars. It now appears extremely probable that the radio-waves observed can be emitted only from the sunspots. The spots show in the centre of the umbra large magnetic fields which vary with the size of the spot[7], and may reach values as high as 4,500 gauss. The direction of the field is axial (that is, perpendicular to the surface of the sun) in the centre of the umbra, but it becomes inclined to the solar radius as we proceed towards the penumbra, and also diminishes in value. The values of the fields are exactly such as will promote the emission of centimetre and metre waves according to the schemes given above, and the intensity of emission will be large enough if we can postulate the existence of a small cross-field, having frequencies of the same magnitude as those of the radio-waves. It is not improbable from what we know of the physical nature of sunspots that such variable fields do actually exist, and may partly be provided by the fields of the 'ordinary'-waves, and the 'extraordinary'-waves corresponding to the condition $f(f - f_h) > \dfrac{4\pi Ne^2}{m}$ coming from below, which may, however, find it impossible to penetrate the electron barrier above (see ref. 1).

These speculations, though far from being established on a sure basis, are given on account of their promise of being able to throw light on a series of extremely interesting phenomena, the origin of which has so far appeared to be wrapped in mystery; the moment is also opportune because experiments on the subject are being undertaken all over the world. If the speculations are on the right lines, it appears that sunspots would also strongly emit radio-waves of the centimetre range. I am not aware if any such observation has yet been made. Further, the emission of centimetre waves by the stars of the Milky Way probably indicates the development of spots in these stars, which should belong to the *G*, *K* and *M* classes. But no spectroscopic observation in verification of such a hypothesis is known to me, and from the nature of things it appears extremely unlikely that any such observation is possible, unless the spots in these stars possess gigantic proportions.

[1] *Nature*, **158**, 549 (1946).
[2] Henyey and Keenan, *Astrophys. J*, **91**, 265 (1940)
[3] Pawsey, Payne-Scott and McCready, *Nature*, **157**, 158 (1946)
[4] Greenstein, Henyey and Keenan, *Nature*, **157**, 806 (1946)
[5] See, for example, Kusch, Millman and Rabi, "Radio-frequency Spectra of Atoms and Molecules", *Phys. Rev.*, **57**, 765
[6] *Phys Rev*, **58**, 441
[7] Nicholson, *Pub Astro. Soc. Pacific*, **45**, 51 (1933).

SOME AMERICAN FOSSIL FORAMINIFERA AND CORALS

UNDER the general title "American Old and Middle Tertiary Larger Foraminifera and Corals" (*Geol. Soc. Amer., Mem.* 9; 1945), Dr. Thomas Wayland Vaughan and Dr. John West Wells have produced a notable contribution to science. Part 1, "American Paleocene and Eocene Larger Foraminifera" (pp. x+175+46 plates) is by Dr. Vaughan; Part 2, "West Indian Eocene and Miocene Corals" (pp. iii+25+3 plates), is by Dr. Wells. It is a far cry from the brief list of foraminiferal and coral species published by Matley in 1932 (*Geol. Mag.*, 69) from the Scotland Beds of Barbados to this splendid double monograph by two well-known specialists on their respective groups.

Part I

Morley Davies's two species of foraminifera (in Matley) have entirely disappeared, to be replaced by twenty-two species and varieties, most of which are new. Study of the handsome plates with which the paper is illustrated is sufficient to convince those familiar with the groups concerned that most, if not all, of the new forms are so distinct as to be worthy of separation.

The portion of the work devoted to the foraminifera is itself divided into two parts; the first is entitled "Paleocene and Eocene Larger Foraminifera from Barbados", and is concerned to describe the material collected by Dr. Alfred Senn during his mapping of the Scotland formation in detail. The age of this has long been established as Eocene; but the new data presented permit a more precise correlation:

Scotland Formation	Upper ..	Middle Eocene
	Lower	Low Middle or Lower Eocene
Boulders from the Joes River mudflows		Palæocene

In the systematic section of this part occurs a considerable discussion of the genus *Miscellanea* Pfender, in the synonymy of which is placed Caudri's genus *Ranikothalia*; the reviewer holds the opinion that *Ranikothalia* is valid and distinct from *Miscellanea*; that *Pellatispirella* Hanzawa 1936 is closely related to, if not identical with, *Elphidium* (*Polystomella*); and that *Sulcoperculina* Thalmann 1938 is, as Vaughan is inclined to recognize, a valid genus: however, these opinions cannot yet be substantiated, and the task of elucidating the distinctions between these five genera will probably have to await the discovery of 'hollow' material of each of the generic types, suitable for the elaboration of the 'gelatin preparations' of Dr. Earl H. Myers, a new method which is briefly described in Part 2 of this memoir.

Six years ago, the old genus *Discocyclina* (*Orthophragmina* auctt.) was raised to family status as the Discocyclinidæ Vaughan and Cole (Cushman, 1940). Here, in the second part, under the title "Catalogue of American *Discocyclinidæ*", Vaughan provides a complete review—almost a text-book—of the family. Almost twenty pages are allotted to a general account embracing structure, classification and ecology; while after thirty pages of species descriptions (including six new species and two new varieties), there is a final chapter of twelve pages on "Stratigraphic Zonation and Geographic Distribution of the Species".

The presence of intra-mural canals in the genus *Discocyclina sensu stricto* is now fully established both by means of Canada balsam preparations—decalcified—and by the novel method of 'gelatin reimpregnation' already referred to. The reviewer considers that the absence of similar canals from *Pseudophragmina* (*Proporocyclina*) is equally certain, since the most careful preparations (Canada balsam decalcified) by Vaughan, by Wright Barker, and by himself have failed equally to expose the faintest trace of this feature either in *Proporocyclina perpusilla* (Vaughan), or in *P. cushmani* (Vaughan), both of which species occur in perfect preservation in eastern Mexico. Further attempts will undoubtedly be made, and this question settled. Should the absence of canals in *Pseudophragmina* (*Proporocyclina*) be proved beyond all reasonable doubt, the homogeneity of the *Discocyclinidæ* at once becomes suspect.

A further point bearing upon this latter theme is the early co-occurrence of the two genera *Discocyclina* and *Pseudophragmina* in the Chicontepec formation of eastern Mexico. Vaughan's stratigraphy of the Chicontepec, based upon Muir's, cannot be compared satisfactorily with that known to the reviewer, but this cannot be entered into here. The deepest (oldest) occurrences of Discocyclinids known to the reviewer have included both *Discocyclina* (*Discocyclina*) spp. and *Pseudophragmina* (*Athecocyclina*) sp.; they lie at about 1,800 ft. below the top of the series containing *Rzehakina epigona*, *Globorotalia velascoensis*, etc. (the Velasco fauna of Cushman), and about an equal distance (thickness) above the Velasco base, where it rests upon the Mendez, in the country south of the Chumatlan River. This clear distinction between the genera at so deep a level in the Palæocene is not suggestive of a monophyletic origin for the family; but at present it is difficult to suggest even one possible source from which this remarkable group might have evolved, and this provides a fascinating object for future research. Certain characters in *Vaughanina* D. K. Palmer 1934 recall the equatorial chambers of a Discocyclinid; but this is mere speculation.

The foregoing remarks embody a few minor points of difference between the author and the reviewer. Their mention must not be allowed to overshadow the enormous value and importance of this work for all palæontologists and stratigraphers studying the American Older Tertiary rock succession. With by far the greater portion of the information and opinion contained therein the reviewer desires to express his full agreement; for the author's achievement he has the deepest admiration and respect.

LIST OF NEW FORAMINIFERAL SPECIES IN PART 1

Orbitolinidæ
Orbitolinoides senni gen et sp nov
Discocyclinidæ
Discocyclina (*Discocyclina*) *harrisoni* sp nov
" " *mestieri* sp nov
" " *turnerensis* sp nov.
" (*Asterocyclina*) *barbadensis* sp nov
" " *franksi* sp. nov
Pseudophragmina (*Proporocyclina*) *schomburgki* sp nov
" (*Athecocyclina*) *soldadensis* Vaughan and Cole, var *calebardensis* var nov.
Pseudophragmina (*Athecocyclina*) *jukes-brownei* sp nov
Asterigerinidæ
Amphistegina senni Cushman sp. nov.
Orbitoididæ
Lepidocyclina (*Polylepidina*) *barbadensis* sp nov.

IN PART 2

Discocyclinidæ
Discocyclina (*Discocyclina*) *caudriæ* sp. nov.
" " *fonslacertensis* sp. nov
" (*Asterocyclina*) *ritteni* sp. nov
Pseudophragmina (*Pseudophragmina*) *bainbridgensis* (Vaughan), var. *angusta* var nov.
(*Pseudophragmina*) *bainbridgensis* (Vaughan), var. *obsoleta* var. nov.
" (*Pseudophragmina*) *novitasensis* sp. nov.
" (*Proporocyclina*) *palmeræ* sp nov
" (*Athecocyclina*) *macglameriæ* sp nov

T. F. GRIMSDALE

Part 2

In Part 2 of the work, Dr. John W. Wells describes the corals, which include eighteen named species and one variety, one comparable species, and seven indeterminate species from the Upper Scotland formation of Barbados, and two species from the Miocene of Martinique. The collection extends very much our knowledge of the Scotland formation corals. Previously only one had been figured by Trechmann in 1925 and five other species (only one named) mentioned by Matley and described by Wells himself in 1934; but their revision in the light of the present suite might be useful now that more is known of the age of the Scotland formation.

The new corals are mostly from the Chalky Mount member, but one form, a new species of *Madracis*, occurs lower down in the Murphys member as well (and, according to Vaughan, p. 20, in the Mount All member also). They are distributed among twenty-two genera and sub-genera, of which two are new. The eighteen named species are new with the exception of two, but as the corals fortunately occur with foraminifera, their Eocene age can be fixed. The sixteen new species are, however, related to Eocene (mainly Middle Eocene) corals of the United States and the West Indies. *Endopachys maclurii* (Lea), one of the previously existing species, and *Balanophyllia irrorata* (Conrad), with which one species is compared, are well known in the American Middle and Upper Eocene, while *Trochocyathus* (*Aplocyathus*) *obesus* (Michelotti) ranges from Eocene to Recent. Of the two new genera, *Sideroseris* is remarkable in being structurally like *Siderastræa*, but simple The other, *Barbadiastræa*, is probably a faviid.

Wells discusses the probable temperature and depth conditions under which the coral fauna lived. He rightly concludes that the evidence favours "a tropical shallow-water, but not littoral, environment", and suggests "a depth at or beyond the minimum temperature (21° C) necessary for vigorous growth of reef corals, which is now approximately 75 metres in the Windward Islands, with a maximum of nearly 200 metres elsewhere in the West Indies".

The two species of Miocene corals from Martinique are interesting. One belongs to *Eusthenotrochus*, a peculiar sub-genus of *Sphenotrochus*, hitherto known only from a Recent South African species and from an Eocene species from the Paris Basin Wells notes an undescribed specimen, probably identical with his new species, from the Miocene Bowden marl of Jamaica. The other species, *Dominicotrochus dominicensis* (Vaughan), occurs in numbers enabling its range of variation to be determined It also suggests that Vaughan's original, ill-localized specimen from the Dominican Republic is also of Miocene age.

H. DIGHTON THOMAS

FOOD AND AGRICULTURE ORGANISATION

THE report of the special meeting on urgent food problems summoned by the Food and Agricultural Organisation of the United Nations at Washington during May 20–27, 1946, as a sequel to a resolution of the General Assembly on February 11, includes an appraisal of the world food situation during 1946–47, issued on May 14, 1946 (Washington · Food and Agricultural Organisation). This emphasizes that a critical world food shortage will continue at least until crops are harvested in 1947, even assuming average or somewhat better than average weather for the rest of 1946 and 1947. In spite of some prospective increases compared with 1945 in both Continental Europe and the Far East, production in 1946 in continental Europe generally as well as rice production in the Far East will still be well below the pre-war level. World stocks of food have been seriously depleted to meet the current crisis, and the incidence of any widespread drought in the months immediately ahead might well be even more disastrous than the effects of the droughts which developed in 1945 and early in 1946.

As regards Continental Europe, the report points out that, even if the production estimates are realized, imports equivalent to about 16 million metric tons of wheat would be required to bring the average consumption to about 90 per cent and of French North Africa to about 95 per cent of the pre-war level. Assuming that sufficient meats, fats and oils, and sugar were available to bring consumption for these commodities to about 80 per cent of the pre-war a head level, some 12·5 million metric tons or 450 million bushels of wheat would be required. Moreover, even with imports at this volume and average consumption at a level ranging from 2,250 calories a head daily in the European–Mediterranean area to 2,550 calories or more in Western Europe, non-farm consumption in some countries would still be under the emergency subsistence level. The urban food situation over wide areas in Continental Europe will thus again be disastrous in the spring of 1947 unless livestock feeding is held to a minimum and supplies are evened out as between different consumer classes and over the year.

The situation in the Far East is equally serious. With average yields the production of paddy (unhusked) rice may be 7 per cent higher than in 1945, but the bulk of this rice will not be harvested until November onwards, and estimates are still 10 per cent short of the pre-war level. Even under favourable conditions, not more than 2 5 million metric tons of paddy is expected to be available for shipment, as against 10 million metric tons in the pre-war period 1935–39. Current reports indicate that the wheat and other grains crops harvested in India are short; and so far as can be estimated, some 25 million tons (wheat equivalent) of cereals or other staple foods would be required to raise Far Eastern diets even to their full pre-war level in 1947—diets which themselves were usually too low for promoting health and working efficiency.

Discussing the export situation, the report notes that supplies are unlikely to be greater in 1946–47 than the amounts actually moved in 1945–46 unless effective measures are taken to reduce the amounts used in the exporting countries. Supplies of wheat are likely to be smaller, and of fats and oils no greater than in 1945–46. Supplies of cane-sugar available for shipment should be about 20 per cent greater, but supplies of meat and manufactured dairy products from the Americas, Australia and New Zealand are unlikely to be any greater. On the other hand, it is anticipated that fish production in 1946–47 will be substantially greater than in 1945–46. Fertilizer supplies are likely to be short in every major producing area, and in very large areas agricultural rehabilitation is necessary to achieve production possibilities.

The survey is completed by a summarized report from the Nutrition Committee which puts the emergency calorie intake requirements at about 2,200 a head daily at the retail level to prevent sections of the population from falling below the danger point. This level may be somewhat lower in eastern and tropical countries generally.

This appraisal provides the basis on which the special meeting during May 20–27 of the Food and Agriculture Organisation framed its recommendations. Those of its first committee related to the establishment of a Research and Information Service to provide the Organisation with further appraisals, to help keep the situation under review, and assist the International Emergency Food Council with information in the same way. Detailed recommendations from the Second Committee, on the Conservation and Expansion of Supplies, include extraction-rates of at least 85 per cent for wheat and rye in all countries for the consumption year 1946–47, and further curtailment of the use of wheat and other grains for feeding animals, as well as proposals for increasing the supplies of food products from the 1947 harvest, covering fertilizers, seeds and equipment. A further section of this report deals with principles and policy to be adopted by individual countries and by the International Emergency Food Council in regard to the production, collection, procurement, allocation and distribution of foodstuffs; if the measures recommended are adopted forthwith and applied consistently throughout 1946–47, a repetition of the hardship and privation of 1945–46 can largely be avoided. The report of yet a third committee is concerned with future machinery;

in addition to recommending close co-operation with U.N.R.R.A., it recommends the establishment of an International Emergency Food Council and a survey of existing organisations dealing with long-term problems with the view of providing any further international machinery required.

SCIENCE AND HUMAN WELFARE

A REPORT of the proceedings of the conference, sponsored by the Association of Scientific Workers, supported by the British Association of Chemists, the Institution of Professional Civil Servants, the Association of University Teachers, the Physical Society, the Nutrition Society and the Institution of Electronics, held in London during February 15–17, has now been published under the title "Science and Human Welfare"*. The four sessions of the conference dealt successively with science and world needs, the implications of recent scientific development, the responsibilities of men of science in modern society and international organisation of science; the addresses given have been somewhat compressed. It is unfortunate that there is no index or contents page.

In opening the first session, Sir Robert Robinson asserted that while the active help of the Governments is needed, the initiative must come from the men of science. He suggested a start might well be made in the battle against malnutrition and disease, and endorsed the Government's decision not to set up a comprehensive Ministry of Science. Mr. Herbert Morrison said that upon a scientific approach to human problems depends the future of man, and that there has been far too little general appreciation of the value of the scientific method. We need over the whole field of science a combination of freedom, initiative and social responsibility. The position of science in China was described by Dr. T'U Chang Wang, while the needs in South Africa were discussed by Miss P. M. Cooke. Prof. J. M. Burgers dealt with the Dutch scene, M. Mathieu with developments in France, Dr. G. Lathe with Canada and Dr. J. A. Simpson with American views.

At the second session, Dr. S. Taylor discussed trends in medical research, Dr. H. L. Richardson dealt with agriculture, Mr. F. Le Gros Clark with food and famine, Prof. M. L. Oliphant with atomic energy, stressing that the first problem here is the control of the nuclear bomb, and Sir Alfred Egerton with chemical engineering, using penicillin manufacture as an outstanding example Colonel Ungerson commented on the necessity for collaboration between the natural scientists and social scientists, and Dr. Bunting on Britain's need for a vast increase in national productivity and the demand for both the highest levels of existing skill and for new kinds of skill.

Opening the third session, Prof. A. V. Hill dealt with the need for men of science to evolve a common standard of ethical behaviour. Prof. B. Farrington, suggesting that science is the main agency in building the human conscience, which is a product of the development of human society, pleaded for the establishment of chairs of history of science. Prof. J. D. Bernal discussed planning and democracy, and said that the most important social responsibility of the man of science is to be aware of what he is doing and to take part in determining what it is. He emphasized the importance of free and rapid communication between all branches of science, and of a really efficient organisation for that purpose.

At the final session, Dr. Julian Huxley discussed the organisation and functions of the United Nations Educational, Scientific and Cultural Organisation, and his plea for world co-operation for science was echoed by Dr. Dorothy Needham in dealing with the situation in China, Dr. D. P. Riley as regards France, and Mr. N. S. Bannerjee as regards India. Dr. Ossowski stressed the growing importance of collaboration in the social sciences, especially co-ordination of research, and Miss L. Ridehatch urged the endowment in Great Britain of more schools of sociology and social science, and greater use of the present theories and findings of social science. Prof. P. M. S. Blackett reviewed the effect of the atomic bomb on the United Nations Organisation and the prospects of control. French views were expressed by Dr. Bonet-Maury and Prof. F. Joliot, while Dr J. A. Simpson put forward the American views on the possibility of an inspection system.

Sir Robert Watson-Watt, summing up, suggested that the basic prescription is for a fuller and better-balanced education. While the scientific man must learn more of the humanities and of the similarity of method in the natural and the social sciences, we need to bring the scientific method within the understanding of the ordinary educated person: there is danger that the intentions of Ministers alive to the possibilities of science may be frustrated by misconceptions in the Civil Service. Finally, referring to atomic energy, he emphasized the need for something more than good aspirations in working out the formulæ required to convert the Atomic Energy Commission into an effective force, and in elaborating any system of control and inspection

* Science and Human Welfare. Pp 72. (Temple Fortune Press, Herbal Hill, London, E.C.1.) 2s. 6d

EARLY GREEK SCIENCE

PROF. BENJAMIN FARRINGTON'S Friday evening discourse at the Royal Institution, entitled "The Character of Early Greek Science", was delivered on February 23, 1945, and has recently been published. It deserves to be widely known; for it corrects some popular misconception, and relates the scientific achievements of early Greeks to their social background. The misconception arose from Aristotle's presentation of the 'physical' philosophers of Ionia as primarily metaphysicians concerned with the general nature of things, and as pioneers in his own line of philosophic thought. Probably even in his time, those early Ionians were represented mainly by summaries of conclusions, without the observations and experiments on which they were founded. But the Ionian objective was more limited, to give "an operational rather than a rational account of the nature of things". Their question was "How it works", and the answer was supplied, not by myths or abstractions, but by practical knowledge within their own control. Thus "technology drove mythology off the field", not indeed from all aspects of Nature, but from those which could be illustrated by the technical equipment of the age. Hence the nomenclature and imagery of science, derived from arts and crafts, which Prof. Farrington illustrates from Lucretius, the Roman interpreter of Anaxagoras; from the caricature of the method by Aristophanes in the "Clouds", by the experimental basis of Pythagorean mathematics, and by the Hippocratic physiology, "to observe the invisible by means of the visible".

This revolution in outlook on Nature was the counterpart and outcome of the contemporary society of Ionia, a great social experiment by a mixed "people without a past", superseding tribal society by reasoned constructions and processes. The two revolutions, intellectual and political, went hand in hand. The working of iron popularized craftsmanship, the alphabet popularized law and justice. "The men who built the cities of Ionia were a new type of men", to be compared with the men of the age of Francis Bacon, intent alike on a "history of nature constrained and vexed by the art and agency of man" and a new age in human history, to be controlled by the same "art and agency" breaking down medieval dogma and prejudice.

Conversely, the premature decay of Greek science, after this bright beginning, accompanied the growth of industrial slavery, and the contempt for craftsmanship among free citizens, encouraged by fourth-century philosophers: whereas medicine, which had become a menial art, remained in touch with the craftsman, and progressed.

Thus it was "practice, not mere observation" that lay at the basis of Greek science. Even Plato admitted at last, after decrying human "improvements on nature", that "those of the arts that *do* produce something serious are all those that blend their power with that of nature, like medicine, agriculture, and gymnastics"—a curious assortment. Man here, as elsewhere in Greek practice, co-operates with Nature. His knowledge of Nature and his power over her are but two aspects of the same thing; and this includes the social background, man's human environment. In Ionia, as in the revival of learning, "for the first time political power was in the hands of free men, who were also masters of productive techniques", and could realize that the creation of man's civilization rests in his own hands—a tremendous responsibility, for 'labour' in other periods also.

FORMAL GENETICS OF MAN*

MAN has obvious disadvantages as an object of genetical study. The advantages are that very large populations are available, and that many serological differences and congenital abnormalities have been intensively investigated.

Some characters are found to obey Mendel's laws with great exactitude. In others the deviations are such as to suggest the existence of a considerable selective mortality, perhaps pre-natal. In yet other cases the observations are biased because we only know that we are investigating the progeny of two heterozygotes when the family includes at least one recessive. Statistical methods which eliminate this bias were described.

Still more complex methods are needed for the detection and estimation of linkage. Several such cases have been detected with greater or less certainty, and the frequency of recombination between the loci of the genes for colour-blindness and hæmophilia is now estimated at 11 ± 4 per cent. If the theory of partial sex-linkage be accepted, it is possible to make a provisional map of a segment of the human sex chromosome.

When a gene is sublethal, as are those for hæmophilia and achondroplasic dwarfism, its elimination by natural selection is in approximate equilibrium with its appearance by mutation, and the frequency of the latter process can be estimated. The mutation-rates at five human gene loci lie between 4×10^{-5} and 4×10^{-6} per locus per generation. These are the only estimates available for vertebrates. The rates per generation are rather higher than those in *Drosophila*, but those per day are so small that much, or even all, human mutation may be due to natural radiations and particles of high energy.

* Substance of the Croonian Lecture of the Royal Society delivered by Prof. J. B. S. Haldane, F.R.S., on November 7.

ACQUISITIONS AT THE BRITISH MUSEUM (NATURAL HISTORY)

THE following notes on recent acquisitions have been issued by the British Museum (Natural History); this material will not be shown yet in the galleries open to the public.

Zoological acquisitions of special interest include two specimens of the Kutch wild ass specially procured and presented to the Trustees by the Maharao of Kutch , this animal is found in the Runn of Kutch, a desert waste in western India between Sind and the State of Kutch. Other additions to the Department of Zoology include 131 mammals from the Gold Coast, including some rare squirrels, presented by Mr. G. S. Cansdale; a collection of birds from Syria and Palestine made by Mr. J. G. Williams; 130 birds from Sierra Leone, containing one new species, presented by Dr. W. Serle; a pale grey variety of the red grouse from Aberdeenshire, presented by Capt. Keith Caldwell; two Komodo dragons, originally presented to the Zoological Society by the late Lord Moyne, who had obtained them from the Island of Flores; a minnow which had lived for twelve years in an aquarium; a valuable collection of a hundred slides of foraminifera purchased from Mr. A. Earland.

The Department of Entomology has received from Mr. Thornley an important collection of Cornish insects, comprising some 26,300 specimens, together with thirteen manuscript diaries and an extensive card index of records. Mr. Thornley is a well-known naturalist now in his ninetieth year, and for the last twenty years he has specialized on the insects of Cornwall. In his earlier years he played a prominent part in the encouragement of nature study in elementary schools. His collection of Cornish insects has already formed the basis of a number of scientific papers, and others are in course of preparation.

The Department of Geology has purchased a large series of sections of petrified fossil plants from the British Coal Measures made over the last fifty years by Mr. W. Hemingway of Derby.

The Department of Mineralogy received numerous gifts of specimens during the war period. Among these may be mentioned two beautiful examples of native gold from Southern Rhodesia: one from Old West Mine, Umtali, presented by Mr. D. V. Burnett in 1941, and the other presented by Mr. Percy Tarbutt, after whom the mineral tarbuttite was named. A very large piece of dark amber which had been bought in Canton in 1860 was presented by Major

J. F. E. Bowring. Another recent acquisition is a large amethyst said by its former owner to be a bringer of bad luck. Fine crystals of emerald in matrix from Columbia were acquired in 1943, and the "Devonshire Emerald", on loan for exhibition before the War, will again appear when the Mineral Gallery can be opened. A similar loan of a magnificent specimen of precious opal weighing 696 carats has been made by Mr. W. Howarth of Lostock, Lancashire; this gem has been named "Pandora", also "Light of Australia". It was found in 1928 at Lightning Ridge in New South Wales, and is of additional interest since it formed part of an opalized fossil bone of a Plesiosaur. It will be exhibited as soon as practicable. A valuable collection of minerals, ores and rocks has been bequeathed to the Museum by the late Gilbert Rigg. This collection includes minerals and ores from mines in many countries—Australia, South Africa, United States, China, Japan, Java and Spain, the zinc mines of New Jersey being particularly well represented. There is also a set of minerals and ores from some lead mines in Wales collected in 1894 and 1896. Several Australian 'tektites' are included in the collection, and there is a large specimen of opal from Australia which in due course will make a fine addition to the exhibited series in the Mineral Gallery.

DISEASES OF FLAX

THE dreaded Pasmo disease was first described from the Argentine in 1911, reached Europe in 1936, and spread to five countries by 1942. It has not yet appeared in Great Britain, but was found on wild flax in Eire in 1944, and afterwards it was seen on cultivated flax (Loughnane, J. B., McKay, R., and Lafferty, H. A., *Proc. Roy. Soc. Dublin*, **24** (N.S.), 10, 89; 1946).

All parts of the plant are affected by the disease, and the seeds may bear pycnospores externally, and mycelium internally. It was established that the latter effects entry by means of the funicle. The disease on young seedlings resembles the effects of *Colletotrichum linicolum* and can be quite severe; but if the plants survive there is then a high degree of resistance until flowering, when they again become susceptible. Spread of disease in the field can be very rapid under conditions of high humidity, evidently by wind-borne and splash-borne spores, and leads to total destruction of the leaves and infection of the bolls. Seed dressings are ineffective against the internal fungal mycelium, but hot-water treatment may prove to be effective. All infected stubble should be destroyed, as the fungus can overwinter and remain virulent until the following spring.

Although Pasmo disease did not reach Eire until 1944, 'flax browning' has been reported regularly since it was first described by Lafferty in 1921, who named the causal organism *Polyspora Lini gen. et sp. nov.* Browning has also been recorded in Britain and in most of the flax-growing regions of the world, and *P. Lini* has always been presumed to be responsible. Isolations from flax plants in Tasmania produced a number of fungi, with species of *Pullularia*, *Cladosporium* and *Alternaria* dominant (H. N. White, *J. Council Sci. and Indust. Res.*, Canberra, **18**, No. 2, May 1945). *Pullularia* and *Polyspora* are evidently closely related, and the author made a comparative study of the morphology, physiology, serology and pathogenicity of a number of isolates from different sources, including Irish material of *Polyspora*. It was not found possible to separate *Pullularia* and *Polyspora* as distinct entities, and the pathogenicity claimed by Lafferty for *Polyspora Lini* could not be confirmed. It was suggested, rather, that *P. Lini* is a saprophyte or very weak parasite which takes an active part in the retting process, but can only attack living plants when the conditions are particularly unfavourable.

H. R. Angell (*ibid.*) grew flax plants in metal drums and found that moderate or scanty supplies of water never resulted in browning, but after flooding, symptoms appeared in about three weeks; and further, that correct drainage following a period of flooding did not prevent the appearance of the disease H. F. DOVASTON

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 18

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Dr. E. G. Richardson "Supersonic Vibrations and their Applications" (Cantor Lectures, 2)

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. J. Proudman, F.R.S.. "The Tides"

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the LONDON SECTION and the FOOD GROUP, at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Mr F P Dunn. "British Chemical Publications" (Jubilee Memorial Lecture)

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr A. H. Mumford "The Trend of Modern Telecommunication".

Tuesday, November 19

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Mr. J C. Hawkins: "Ploughs and Ploughing".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Physical Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Dr L R Bishop. "Post-War Barley Problems".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p.m.—Prof James Gray, F.R.S.: "Locomotory Mechanisms in Vertebrate Animals, 4, Relationship of Limb Form to Habit and Environment, Evolution of Types for Climbing and Running".*

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. Tage Kemp. "Fifteen Years' Experience of Negative Eugenics in Denmark".

INSTITUTE OF PETROLEUM, NORTHERN BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6 p.m.—Mr. J. B. J. Dunn: "Greases".

SOCIETY OF DYERS AND COLOURISTS, HUDDERSFIELD SECTION (at Field's Café, Huddersfield), at 7.30 p.m.—Mr. W. Lodge "Wrinkles".

Wednesday, November 20

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr R. Davis, Dr A E Austen and Prof Willis Jackson: "The Voltage Characteristics of Polythene Cables".

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St James's Park, London, S.W.1), at 6.30 p.m.—Mr. S. C. Herbert "A Hydraulic System applied to the Automatic Control of Water Gas Manufacture".

ROYAL INSTITUTE OF CHEMISTRY (in Room 1, Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6.30 p.m.—Annual General Meeting

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (at the Midland Hotel, Derby), at 7 p.m.—Mr. C C. Wilcock. "Preparing, Dyeing and Finishing of the New Fibres".

CHEMICAL SOCIETY, EIRE SECTION (joint meeting with the LOCAL SECTION of the ROYAL INSTITUTE OF CHEMISTRY, in the Chemical Department, University College, Upper Merrion Street, Dublin), at 7.30 p.m.—Dr. T. G. Brady: "Biochemical Microtechnique".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Outlook in Physics" (to be opened by Prof. M. L. E. Oliphant, F.R.S., and Dr. E. C. Bullard, F.R.S.)

Thursday, November 21

CHEMICAL SOCIETY, NOTTINGHAM SECTION (joint meeting with the UNIVERSITY COLLEGE PHYSICAL AND CHEMICAL SOCIETY, in the Large Chemistry Theatre, University College, Nottingham), at 4.30 p.m.—Dr. F. L. Rose: "Some Aspects of the Chemistry of Paludrine".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m.—Mr J. C Allan, Mr G. A Smith and Mr R. I. Lewis "The Panasquiera Mines, Portugal—Wolfram Mining and Milling; Labour Organization"

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p m —Dr. Frank W Jane · "A New Species of *Chlororrhabdion*", Mr A H G Alston "Systematic Botany and Botanical Collections in Germany" Dr A Tindell Hopwood "Contributions to the Study of some African Mammals, 4, The Skulls of Lion, Leopard and Cheetah".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p.m.—Prof N. F. Mott, F.R S : "Problems before Theoretical Physics, 1" *

CHEMICAL SOCIETY, NORTH WALES SECTION (joint meeting with the UNIVERSITY COLLEGE OF NORTH WALES CHEMICAL SOCIETY, LIVERPOOL SECTION, and the UNIVERSITY OF LIVERPOOL CHEMICAL SOCIETY, in the Department of Chemistry, University College, Bangor), at 5.30 p.m —Dr. G. M. Bennett : "Nitration in Sulphuric Acid".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Mr. C Lawton and Mr V. H. Winson. "The Development and Design of Colonial Telecommunication Systems and Plant" and "The General Planning and Organization of Colonial Telecommunication Systems".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m —Prof G W. O. Howe : "The Ionosphere and the Transmission of Radio Waves"

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the SOUTH YORKSHIRE SECTION of the ROYAL INSTITUTE OF CHEMISTRY, the SHEFFIELD SECTION of the CHEMICAL SOCIETY, and the SHEFFIELD UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Western Bank, Sheffield), at 6 p m —Dr. C. H. Desch, F R S : "Chemistry in the Metallurgical Industries"

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at Gas Industry House, 1 Grosvenor Place, London, S.W 1), at 6 p.m —Mr L. H. Griffiths "Latex Cement and other Flooring Compositions".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 7.30 p m.—Mr. H. D C. Waters, Mr. A. R Caverhill and Mr P. W. Robertson "The Kinetics of Halogen Addition to Unsaturated Compounds, Part 12, Iodine Catalysis of Chlorine and Bromine Addition to Ethyl Cinnamate"; Mr. A Robertson and Mr. W A. Waters. "Evidence for the Homolytic Bond Fission of 'Positive Halogen' Compounds".

CHEMICAL SOCIETY, SOCIETY OF CHEMICAL INDUSTRY and ROYAL INSTITUTE OF CHEMISTRY, EDINBURGH AND EAST OF SCOTLAND SECTIONS (at the North British Station Hotel, Edinburgh), at 7.30 p m. —Prof. F. S. Spring. "Some Developments in the General Methods of Organic Chemistry".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 8 p.m.—Laboratory Meeting

TEXTILE INSTITUTE, MACCLESFIELD, LEEK AND DISTRICT SECTION (joint meeting with the LEEK TEXTILE SOCIETY, at Nicholson Institute, Leek), at 8 p.m.—Mr. A. B. Armstrong "Motion and Time Study"

Friday, November 22

INSTITUTE OF PHYSICS, INDUSTRIAL SPECTROSCOPIC GROUP (in the Department of Applied Science, The University, St. George's Square, Sheffield), at 2.15 p.m.—Annual General Meeting Mr. D. M. Smith · "The Spectrographic Analysis of High-purity Materials".

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 3 p.m.—Dr. E. H. Linfoot: "The Diffraction Theory of the Phase-Contrast Test"; Mr. E. W. Taylor. Demonstration of a New Phase-Contrast Microscope; Phase-Contrast Films

INSTITUTE FOR THE STUDY OF ANIMAL BEHAVIOUR (at the Zoological Society, Regent's Park, London, N W 8), at 4 p.m.—Dr. R. Braude "Some Observations on the Behaviour of Pigs in an Experimental Piggery"; Mr. R Phillips "Some Observations upon Behaviour in Sheep with particular reference to Grazing Habits and to Climate".*

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4 30 p.m.—Geophysical Discussion on "English Oilfields" (Speakers: Dr. E. C Bullard, F.R.S., Mr. L. H. Tarrant, Dr. J. Phemister and Mr. J. E. R. Wood).

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL (in Lecture Theatre No 1, University Street, Gower Street, London, W C.1), at 4.30 p m.—Dr. P. A. Owren "New Factors concerned in the Coagulation of Blood".*

CHEMICAL SOCIETY, NEWCASTLE AND DURHAM SECTION (at King's College, Newcastle-upon-Tyne), at 5 p.m.—Dr. J. L. Simonsen, F.R S.: "Insecticides" (Bedson Club Lecture).

GENETICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5 p.m.—Prof. Tage Kemp: "Multiple Factors in Morbid Inheritance" (accompanied by a film "The Rat Dwarf")

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m. —Dr. F. M. Bruce "The Design of an Ellipsoid Voltmeter for the Precision Measurement of High Alternating Voltages" and "Calibration of Uniform-Field Spark-Gaps for High-Voltage Measurement at Power Frequencies".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St-James's Park, London, S.W.1), at 5.30 p.m.—Mr. Harold Waghorne: "Continuous Braking of Trains"; Mr. R I. D. Arthurton: "Automatic Couplers for Railway Rolling Stock".

INSTITUTE OF FUEL, SCOTTISH SECTION (at the Royal Technical College, Glasgow), at 5.45 p.m.—Mr. G. C. Scolding. "Underfeed Stokers"; Mr. A. Bujnowski: "Gas Firing"; Mr. A. B. S. Laidlaw: "Oil Firing".

INSTITUTE OF THE PLASTICS INDUSTRY, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 6 45 p m — Chairman's Address

Saturday, November 23

INSTITUTE OF PHYSICS, INDUSTRIAL SPECTROSCOPIC GROUP (in the Department of Applied Science, The University, St George's Square, Sheffield), at 2 p m —Mr. Braudo and Mr Clayton "The Development of the Metro-Vick Spark Unit"

Friday, November 22—Sunday, November 24

WOMEN'S ENGINEERING SOCIETY (at Birmingham).—Conference on "Education and Training for Engineering".

Saturday, November 23

(At the University, Edmund Street, Birmingham).—Mr C A. Harrison "The Aims of Education", Mr John Maslin "Practical Steps in the Inauguration of a Training School", Miss Verena Holmes: "The Co-ordination of Theory and Practice in Engineering Training"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

WILLIAM JULIEN COURTAULD CHAIR OF HELMINTHOLOGY tenable at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W C 1 (November 21).

LECTURER IN PHYSIOLOGY up to B Sc standard—The Principal, Chelsea Polytechnic, Manresa Road, London, S W 3 (November 22).

CHEMIST for fundamental researches in connexion with a small team of Marine Biologists at Millport, Isle of Cumbrae, on anti-fouling composition for marine use—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1 (November 23)

LECTURER IN BIOLOGY, a LECTURER IN PHYSIOLOGY OR BIOCHEMISTRY, and a LECTURER IN HISTOLOGY AND EMBRYOLOGY—The Secretary, Glasgow Veterinary College, Inc., County Buildings, 149 Ingram Street, Glasgow, C.1 (November 23).

AGRICULTURAL ASSISTANT to the Education Committee—The Chief Education Officer, Shire Hall, Cambridge (November 23).

ASSISTANT LECTURER IN MECHANICAL ENGINEERING—The Registrar, College of Technology, Manchester (November 25).

LECTURER IN BOTANY, with special qualifications in Mycology—The Secretary, University Court, The University, Glasgow (November 30)

LECTURERS (1 or 2) to teach PHYSICS or CHEMISTRY, with some APPLIED MATHEMATICS or MATHEMATICS, to students up to general B Sc standard—The Registrar, Loughborough College, Loughborough, Leics.

LECTURER IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Clerk and Treasurer, Dundee Technical College, Bell Street, Dundee.

SENIOR LECTURERS IN PHYSICS AND MATHEMATICAL PHYSICS, LECTURERS IN PHILOSOPHY AND ZOOLOGY, and ASSISTANT LECTURERS IN HISTORY, PHYSICS AND MATHEMATICS, in the University of Otago, Dunedin, New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W C 2

TECHNICIAN IN THE CHEMISTRY DEPARTMENT—Prof. C. S. Gibson, F.R S., Chemistry Department, Guy's Hospital Medical School, London Bridge, London, S.E 1.

LABORATORY TECHNICIANS (2) IN THE PHYSIOLOGY DEPARTMENT—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.1.

ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSIOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W 8

LECTURER IN EDUCATION (Science graduate, experience in use of visual techniques essential)—The Registrar, University College, Leicester.

METEOROLOGISTS for service in the Sudan—The Sudan Agent, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Meteorologist'.

TECHNICIAN FOR DEPARTMENT OF MEDICINE—The Professor of Medicine, Medical School, The University, Birmingham 15.

HONOURS GRADUATE IN CHEMISTRY (young), to carry out research on adhesives and emulsions in connexion with the sizing for weaving of synthetic yarns, and a JUNIOR RESEARCH OFFICER (Hons. Graduate in Physics or Applied Mathematics), for research on the weaving behaviour of textile yarns in relation to their mechanical and physical properties—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

EXECUTIVE SECRETARY—The Honorary Secretaries, Royal Meteorological Society, 49 Cromwell Road, London, S.W.7.

LECTURER IN ELECTRICAL AND MECHANICAL ENGINEERING—The Principal, Faraday House, Southampton Row, London, W.C 1.

SENIOR ASSISTANT IN GEOLOGY, with special reference to Mining, an ASSISTANT IN BOTANY AND GENERAL BIOLOGY, and an ASSISTANT IN GEOGRAPHY AND ELEMENTARY MATHEMATICS—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan.

LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING—The Principal, Marine School, South Shields.

LECTURER IN APPLIED MECHANICS at the Royal Naval College, Greenwich—The Director, Education Department, Admiralty, London, S.W.1.

SCIENTIFIC OFFICERS (2) for the Fuel Technology Section of the Plant Engineering Division, to carry out operational research in the Iron and Steel Industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Plant Engineering Division'.

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PATENT LAW REFORM AND THE CHEMICAL INDUSTRY*

UNDER the title "Memorandum on Patent Law Reform" there have now been published under one cover Parts 1 and 2 of the evidence submitted to the Board of Trade Patents Committee by the Joint Chemical Committee on Patents, which consisted of representatives of the Association of British Chemical Manufacturers, the Biochemical Society, the British Association of Chemists, the Chemical Society, the Institution of Chemical Engineers, the Royal Institute of Chemistry, the Society of Chemical Industry, and, for Part 1, the Wholesale Drug Trade Association. Part 1 of this Memorandum consists of answers to the fourteen questions issued by the Departmental Committee for the guidance of witnesses, together with the dissenting views of Dr. G. H. Fraser of the Therapeutic Research Corporation, Ltd., and was submitted to the Board of Trade Committee in September 1944. Part 2 covers the wider aspects of patent law reform and was submitted in June 1946. A number of the recommendations have already been adopted in the Second Interim Report of the Departmental Committee which was discussed in *Nature* of July 6, p. 1.

Like the Board of Trade Committee, the Joint Chemical Committee believes that the abuses of patent monopoly by the suppression of inventions so often charged against patentees in the popular Press are usually found on examination either to be non-existent or to be due to the abuse of the power of wealth ; and in its view, the remedy lies in refusing grant of invalid patents, strengthening Section 27 of the Acts intended to provide a remedy against abuse, and considerable reduction in the costs of a successful defendant in the Patents Court. The endorsement of all patents as 'licences of right' either on grant or after three years is not recommended ; but it is recommended that the Comptroller-General of Patents should have power to refuse a patent for lack of subject-matter on the further statutory grounds that the invention is not a manner of manufacture or otherwise of industrial significance, and that it does not contribute to the art any item of new knowledge.

This question of subject-matter is discussed more fully in Part 2, where the criteria are expressed in three short definitions. An invention, in order to have subject-matter, must be based upon a discovery. A discovery is the contribution of some item of new knowledge to the art. An item of knowledge is new if it is not ascertainable from the prior art, that is, is not to be found described in the prior art and is not deducible by a strictly syllogistic process of reasoning from data to be found in the prior art. Definition of patentable subject-matter in the Act in these terms is recommended, and further that an applicant should be required to set out in his complete specification a statement of the discovery upon which his invention is based ; when validity is

* Memorandum on Patent Law Reform. By Joint Chemical Committee. Pp. 118. (London : Association of British Chemical Manufacturers, 1946.) 3s.

challenged, however, he should be entitled to plead any new knowledge, expressed or implicit, which is contained in the description of his invention in the specification.

The Committee then proceeds to discuss selection patents or 'invention by selection' on the lines of the well-known judgment of Mr. Justice Maugham revoking three patents of the I. G. Farbenindustrie A G., and recommends that a definition substantially in accordance with that judgment, and including a rule based on a recent decision of Mr. Justice Evershed sitting as Patents Appeal Tribunal on Dreyfus Application 542034, be incorporated in the Patents Act. An inventor must bring himself within the rules for selection if there is a prior disclosure or claim of his invention which is not merely a statement of desiderata but prescribes, though only in general terms, the substances, agencies, or means by which his invention is effected. In these circumstances the requirements for patentability as a selection from the general disclosure or claim are discovery of a previously unrecognized advantage shown by the selection and not common in the field of the general disclosure or claim, and limitation to a manufacture based on that discovery. In addition, there must be novelty (the selected members must not have been specifically mentioned before) and adequate description of the invention, that is, of the advantage which justifies the selection.

The Memorandum next suggests that the scope of product claims should be defined as protecting the product, when made by the process described or by any process which is non-inventive over it, thus bringing chemical inventions into line with other inventions. For 'chemical process' is suggested the definition: "a process in which a product is formed by a re-arrangement or re-distribution of atoms of chemical elements present in the starting materials, or by intra-atomic change". 'Chemical invention' means an invention involving as an essential for its operation a chemical process. The Memorandum also outlines a scheme for Empire patents, but recognizes the inherent difficulties of such an arrangement. Various modifications of opposition procedure are proposed, including notification of anticipations without formal opposition, filing of an agreed "Technology of the Case", limitation of evidence to statements of facts and exclusion of argument, and limited extensions of time for filing evidence. As new grounds for opposition it is proposed there should be added: (i) that the invention involved no discovery (as defined) over published knowledge, and (ii) that the invention had been made available to the public by prior uses amounting to publication.

Freedom of amendment within the scope of the original disclosure is also suggested. Amendments which enlarge the claims (always within the scope of the original description) should be allowed, subject to third-party rights, a new definition of which is proposed. The Memorandum deals at some length with the terms and conditions of licences, distinguishing between patent licences and patent assignments, and recommends that both should always be registered, and the terms and conditions disclosed to the Comptroller-General of Patents, who should have power to open them to public inspection where he finds illegal conditions imposed. The sanction of an infringement action should not be available for terms and conditions which are essentially of the nature of a trade agreement, and the patentee should not be allowed to assert rights which extend beyond those granted by the Letters Patent.

These proposals should put a stop to many abuses of monopoly, and to the use of patents to impose a system of private commercial law.

Inclusion in the Act of a new section setting out the rights and obligations of a patentee is also recommended. The miscellaneous proposals include a general right of appeal from all decisions of the Comptroller, companies to be entitled to be sole applicants for patents, extension of provisional rights by post-dating up to six months, list of Patent Office citations to be printed at the end of a specification, printing of refused specifications with the consent of the applicant, and correspondence with patent agents to be privileged. The reprinting or photographic reproduction of out-of-print specifications, abridgments, indexes and reports of patent cases to be undertaken as soon as possible, and all printed specifications to be kept in print for fifty years after their date, are other recommendations which will be of interest to many outside as well as inside the chemical industry.

SUPERNATURAL OMNIBUS

Witchcraft and Black Magic

By Montague Summers. Pp. 228 + 16 plates. (London: Rider and Co., Ltd., 1946.) 28*s*. net.

IT will be news to many that "the Cult of Satan, still enthusiastically recruiting in every land, has enormously increased even within the last five and twenty years". All the more reason for a historical and scientific demonstration of this thesis. The writer of this book deprecates the "few freakish and facile pens" and the "books made of paste and scissors" which have dealt with it already; but he does not seem to realize how nearly his own pages come into this condemnation. Though he quotes several of the well-known collections of material in his introduction, he seldom gives 'chapter and verse' for his statements, and is content, for example (p. 16), with the *Daily Telegraph's* account of "a much-talked-of case", in April 1934, when what is expected is at least a reference to the *Law Reports*: similarly, "a recent writer 1929" is insufficient authority for a dictum about "white witchcraft". No one doubts (p. 27) that Blackstone ("Commentaries", 4, 60; 1765) wrote that "to deny the possibility, nay, the actual existence of witchcraft and sorcery is at once flatly to contradict the revealed word of God", and quoted "examples" and "prohibitory laws" which "at least suppose the possibility of a commerce with evil spirits"; that John Wesley ("Journal", 1768) rather quaintly wrote that "the giving up of witchcraft is in effect giving up the Bible"; that Dean Inge (p. 24), preaching in 1932, had "not the slightest doubt that Christians are enjoined to believe in a positive, malignant, spiritual power"; or that Dr. Heywood, Bishop of Ely, on June 23, 1938, commenting on late frosts, thought that "discarnate rebellious spirits may have some temporary and limited power to exercise evil influences in the realm of Nature as they apparently have in the realm of humanity": a belief which the author of this book supports (p. 32), and devotes himself to substantiate. His "Supernatural Omnibus" is in its twentieth thousand. The older witnesses cannot be cross-examined now; but what we want to know is documented experimental detail about "one of the best known figures in the University of Oxford not much more than ten years ago", who "was commonly believed to entertain a familiar", and had a spare shadow which vanished if he passed St. Aloysius's or Blackfriars (p. 48) What happened at St. Mary's or the Friends' Meeting House? We look for evidence, likewise, about "Polstead, Suffolk, a district notoriously infested by witches" (p. 49); about Mother Redcap of Horseheath, Cambs., who died in 1926 (*Sunday Chronicle*, Sept. 9, 1928); or the "famous Paris clairvoyante" (name suppressed), whose familiar "St. Gabriel" foretold a fire at a bazaar (p. 103). Egyptian magic is only illustrated (pp. 109–110) from the British Museum's mummy No. 22542, with the comment that "it is a grievous and a very terrible thing that an exhibition of mummies and mummy-cases is permitted".

Continuity between older and recent practices is confirmed by reported discoveries of formulæ from the *Petit Albert*, and copies of magical books, in the hands of persons sentenced in Jamaica for witchcraft (pp. 127–28), and for similar offences in England (pp. 131–32). But beliefs and practices are not substantiated because they are old.

In the case of François Courtcon (pp. 155–159) published in 1794, the author begins to put forward his own hypothesis. He quotes from the *Daily Express* in January 1934 a case of 'overlooking' in Dorset, and multiplies it by "scores that remain unknown" (p. 163). He quotes "the Press" in December 1934 for the existence of four active "occult magic circles" in London (p. 180), and he skims recent books on the Obeah cult in Jamaica, which he attributes to "that false god, Satan, the prince of hell" (p. 191). The cat is now out of the bag, and the rest of the book, though more explicit, is no better documented, and need not detain us. For a *Templum Palladicum* discovered in Rome in 1895 no reference is given at all (p. 209).

Frankly, this book is of the 'paste-and-scissors' quality which its author professes to deplore: it leaves witchcraft and magic exactly as they were.

JOHN L. MYRES

THE 'SQUARES' METHOD FOR POTENTIAL PROBLEMS

Relaxation Methods in Theoretical Physics

A Continuation of the Treatise on Relaxation Methods in Engineering Science. By R. V. Southwell. (Oxford Engineering Science Series.) Pp. vii + 248. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 20*s*. net.

SOME six years ago Dr. Southwell published his now famous treatise on "Relaxation Methods in Engineering Science", in which he gave an account of the investigations of his school of research workers into the applications of relaxation methods to systems of finite freedom and to continuous systems in one dimension. In this second treatise he expounds the applications of the relaxation method to numerous problems of continuous systems in two dimensions, with special reference to plane-potential and associated problems. A great variety of physical problems is considered in detail, the examples being selected from the domains of electricity, hydrodynamics, electricity and magnetism, the conduction of heat and hydraulics. In all, some thirty-five problems are discussed with full numerical details, so that this volume forms a remarkable tribute to the energy and enthusiasm of the author and his fellow workers.

This volume, like its predecessor, is deliberately limited to the researches of Dr. Southwell and his team, and does not attempt to discuss the earlier theoretical work of Courant on the extensive practical investigations of Thom It is complete in itself and provides all that is necessary for the student who wishes to master this increasingly important mathematical technique. The abundant diagrams and numerical tables form most valuable supplements to the exposition in the text. This latter is strictly elementary in character and employs no concepts or methods save those which should already be familiar to the mathematical physicist or engineer.

The growing success and popularity of relaxation methods, which Southwell's work has done so much to promote, have made it no longer necessary to defend the use of these methods, which have in fact become well recognized and established weapons of numerical computation. It may, however, be useful to give a brief account of the essential features of the method as applied to the simplest two-dimensional problem—the numerical evaluation of a potential function which takes assigned values on a given closed boundary.

Such a potential function, say $f(x,y)$, satisfies Laplace's equation, $\partial^2 f/\partial x^2 + \partial^2 f/\partial y^2 = 0$, in a domain A, and takes prescribed values on the curve B which bounds A. It is also well known that the function which is required will minimize the integral $\iint\{(\partial f/\partial x)^2 + (\partial f/\partial y)^2\}\,dxdy$ taken over A, subject to the boundary condition on B. Now the first step in relaxation theory is to replace the domain A by a lattice of equal squares which covers A, and the rectilineal boundary of which agrees as closely as possible with B. The value of f is then sought at each point of this lattice.

Laplace's differential equation is then replaced by the associated difference equation, $f_A + f_B + f_C + f_D = 4f_P$, where the symbols denote the values of f at the corners of the square $ABCD$ with centre P. The function which satisfies this equation at all the points P of a square lattice covering A and which takes assigned values at the boundary points will minimize the sum,

$$D = \Sigma\{(f_A - f_P)^2 + (f_B - f_P)^2 + (f_C - f_P)^2 + (f_D - f_P)^2\}$$

taken over all the points P of the lattice.

The second step in relaxation theory is to determine the best possible way of improving any approximation to f given by numerical values at the lattice points. In practice we can alter the value of f only at one point at a time; and it is easily proved that the best way of altering the value of f at a point P is to replace f_P by $\frac{1}{4}(f_A + f_B + f_C + f_D)$. This change reduces the value of D by the maximum amount.

Relaxation technique then consists in systematically working over the lattice and everywhere replacing the original approximate values of f by the means of its values at the neighbouring corner points. The successive approximations found in this way converge to the exact solution of the difference equation—and this solution is an approximate solution of the original Laplace's equation.

The theory and practice are equally simple. All that is demanded of the computer is inexhaustible patience and energy. The method is clearly capable of wide extension to many other problems of mathematical physics. In practical computation there are numerous devices for facilitating the application of the general principle, but these artifices are best learnt, pencil in hand, reworking such problems as are described in Southwell's treatise. G TEMPLE

LIFE AND FOOD OF INSECTS

Insect Dietary

An Account of the Food Habits of Insects. By Prof. Charles T. Brues. Pp xxvi+466+22 plates. (Cambridge, Mass.: Harvard University Press; London · Oxford University Press, 1946.) 28*s*. net.

IN these days the amateur in natural history needs to absorb more and more of the products of scientific study if he is to get the fullest enjoyment from his observation of Nature; and the professional biologist has equal need of the knowledge, the enthusiasms and the gift for sympathetic observation of the field naturalist if his biology is to remain the science of living things. Therein lay the virtue of the late W. M. Wheeler's vivid books on insect life, "Social Life Among Insects" and "Demons of the Dust". These are inexhaustible mines of information about the creatures with which they deal; but, throughout, the natural history is informed by a profound knowledge of scientific theory and, for that matter, of the philosophical implications of science.

It is in this light that the book on the diet of insects by Prof. Brues, for many years an intimate colleague of Wheeler at the Bussey Institution at Harvard, is to be viewed. The reader is not to look for a carefully documented and systematic account of the vitamin requirements of insects, of the relative nutritional value of different proteins or amino-acids, of the ability of insects to utilize specific sugars, or of the properties and distribution of their digestive enzymes. Rather, the author displays the whole vast panorama of ravenous jostling insects, carnivorous and vegetarian, saprophytic, predaceous and parasitic; sucking the juices of plants and animals; destroying the crops of man or devouring one another. The importance of detailed scientific analysis is fully recognized, but as a rule the field is lightly sketched in; the reader is then told where to go if he wishes to pursue the subject for himself.

Getting food is such an important part of life that the author is led into many by-ways of the natural history of insects. The diversity of insects, their abundance as species and as populations are reviewed. Their range of habitats comes in for discussion; the lack of marine insects; aquatic life; adaptation to existence in the desert, in caves, in the soil, or as parasites. The colours of insects are found to be a part of the story; so is the determination of castes in social insects—how far is this controlled by food, and how far by genes? Seeking food for its own consumption or providing for its offspring involves the insect in all the complexities of behaviour. So we have sections dealing with the selection of host plants by the egg-laying female; ancestral memory; conditioning, and biological races associated with particular food plants. There is no special emphasis on economic entomology, but this necessarily comes frequently into the picture; and the use of insects in the control of weeds or of other insects and such-like topics are lightly touched upon.

This catalogue represents only a fraction of the subjects covered; the book indeed amounts almost to a general natural history of the insects. It is written in a discursive style and the author enjoys an occasional joke. The author refers to the aberrant coccinellids of the genus *Epilachna* as vegetarian insects which can proudly trace their distaste for flesh as far back as Mesozoic times; and what are commonly contrasted as determinate evolution and orthogenesis, he depicts as natural selection and natural cussedness. The reader who is fond of insects will find new facts to interest him on every page; and after each chapter there is an elaborate classified bibliography which will be invaluable to the serious student. For those who can remember what a host of topics are embraced by 'insect dietary', this book will prove a most useful source of reference. It has good indexes to authors and subjects, and the text is lightened by a series of well-chosen line drawings and excellent photographs, mostly by the author.

V. B. WIGGLESWORTH

BIOCHEMICAL PERSPECTIVE

A Textbook of Biochemistry

By Prof. Philip H. Mitchell. Pp. xv+640. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 25*s*.

THIS addition to an already lengthy list of textbooks of biochemistry which have appeared recently, for the most part in the United States, is, we may say at once, very well done. A glance through its pages shows the very extensive changes which have come over the biochemical scene in recent years. The older books began with rather lengthy accounts of the necessary background of organic chemistry, and sometimes physical chemistry; leading to a description of those compounds which are of importance as the products or intermediaries of vital processes. The materials of which living organisms are constructed now occupy the centre of the stage, and this book, which excellently illustrates the trend and direction of the science, spends very little time on the organic and physical background. Indeed, in the preface the author states his belief in no uncertain way: "The central theme and the chief goal of biochemical study is an explanation of the real chemistry of life. While the chemistry of foods and of dead tissues is helpful corollary material, the essentials are the reactions of living protoplasm. Accordingly emphasis in the text has been given and major space allotted to such subjects as the constitution and activity of enzymes, the intermediary reactions of anabolism and catabolism and the vital significance of hormones and vitamins".

After preliminary chapters on carbohydrates (this seems unnecessary if organic chemistry is taken as known), on photosynthesis and on fats, the author plunges at once into the central part of the subject—the proteins and amino-acids, the nucleoproteins and nucleic acids, the vitamins and enzymes. With this basis he can then deal with what he regards as his most important task—the study of nutrition—though not everyone would agree that "the chief present day mission of biochemistry would seem to be the establishment of nutrition as a science rather than leaving it as one of the arts". With this in mind he proceeds to the study of the various types of biochemical processes and systems: digestion, blood and lymph, respiration, biological oxidation, carbohydrate and protein metabolism, etc.; and winds up with interesting and up-to-date accounts of the chemistry of hormones and chemotherapy.

The reviewer, a recent recruit to the biochemical field, found the book very informative. To students it will be a mine of information, and it can also be recommended to chemists in general who want a readable and not too lengthy account of what has been going on in biochemistry in recent years. It is up to date, as may be judged from the following matters, which are treated in considerable detail: the penicillins; other antibiotics such as gramicidin, tyrothricin, streptomycin and bacitracin; œstrogenic substances, the pituitary hormones, the gonadotropins, the renin-hypertensin system, folic acid (to a point just preceding the recently announced structural formula of Angier and others). There is a good collection of references for further reading at the end of each chapter, chosen from British and American journals, but excluding other languages.

Many text-books give an unwarranted impression of completeness, and it must be counted a virtue in a text-book if it goes out of its way to emphasize the unknown. A final quotation, taken from an epilogue to the chapter on biological oxidation, will indicate the author's admirable attitude. "In spite of all that is known about bio-oxidation, it is a drama of which the plot is still unsolved. The biochemist is a stage hand. His position in the wings has enabled him to get acquainted with some of the actors (enzymes), to see the properties (foodstuffs) going on the stage . . . to know that the play goes to a successful conclusion. . . . But how the plot works out, he does not know." The same might well have been written as the epilogue of the whole book.

J. A. V. Butler

CLINICAL STUDIES ON MALE FERTILITY

Studien am menschlichen Sperma
Von Charles A. Joel. Pp. 154+10 plates. (Basel: Benno Schwabe und Co., 1942.) 20 Swiss francs.

PART 1 of this book is a review of seminology from ancient to modern times. It is well documented with references, but is little more than a list of authors and their discoveries arranged in historical order. It fails to arouse interest in a subject which might have been presented as one of the most important in biology and medical science.

The second and principal part of the book deals with the investigation of human semen from the clinical point of view, and is largely based upon the author's examination of more than a thousand semen samples. Methods of collection, preparation and examination for sperm density, motility and morphology are described very fully. This section of the book will be most useful to the clinician.

According to the characteristics of the semen samples the author divides cases of impaired fertility into five groups. The groups cover a very wide range from complete aspermia to slight oligospermia. These extreme cases are, of course, easily diagnosed from the semen characteristics, but the author does not make clear what degree of reliability can be attached to the results of semen examination, and how accurately they can be used for the diagnosis and prognosis of less extreme cases of impaired fertility. There is no critical analysis of the case histories.

A short section of the book is devoted to chemical experiments with human sperms. The author's own experiments are neither extensive nor very conclusive.

The section on the enzymes of the semen is confusing. This is partly due to the limitations of the material. Human semen samples, especially clinical specimens, are of small volume, contain relatively few sperms and have a high but variable content of the accessory fluids. They are therefore not very suitable material for the study of the metabolic processes of the sperms. On the other hand, the semen of the domestic animals is available in good quantity and makes ideal material for enzymic studies on the respiratory processes. It is unfortunate that the author has not had access to the recent work on sperm metabolism carried out on farm animals in the United States and Great Britain. His own experiments deal primarily with reactions in the seminal fluids and have little bearing upon sperm metabolism.

The section on the biology of the human spermatozoa is confined to a study of survival in the female tract. The author found motile sperms in the vagina up to fifty-five minutes, in the cervix up to forty hours, and in the uterus up to twenty-five hours.

A very short chapter on the role of the marriage partners in sterile marriages completes the book. It is estimated that about 49 per cent of sterile marriages are due to the male. In about 25 per cent sterility could not be attributed to either partner by clinical examination.

Arthur Walton

REVIEWS OF CURRENT PHYSIOLOGY

Annual Review of Physiology
Edited by James Murray Luck and Victor E. Hall. Vol. 8. Pp. viii + 658. (Stanford University P.O., Calif.: Annual Reviews, Inc.; London: H. K. Lewis and Co. Ltd., 1946.) 5 dollars.

IT is the declared editorial policy of the "Annual Review of Physiology" that a review should not only survey the recent contributions to the field but also "appraise them critically and evaluate with discrimination the present status of the subject". Of the twenty-five reviews which comprise Vol. 8, 1946, many fall short of this ideal. The reviews of energy metabolism, respiration, physiology of the skin, digestive system, liver and bile, blood coagulation, blood cytology, heart, reproduction, are, for the most part, uncritical compilations of published data. The reviewers of applied physiology, aviation medicine and the physiology of heat and cold have been considerably hampered by the continuing ban on the publication of much war-time research; but a considerable amount of new work on the effects of climatic extremes and anoxia is covered. Nerve and synaptic transmission by G. H. Bishop, the somatic functions of the central nervous system by A. E. Walker and the visceral functions of the nervous system by K. Hare can all be commended as critical and stimulating reviews. Hare's article is particularly valuable in developing the modern view that there is no functional antagonism between the sympathetic and parasympathetic systems. Developmental physiology by L. B. Flexner records further rapid growth in this new field, and it is interesting to note that the *in vitro* fertilization of human ova has been reported.

R. F. Pitts presents an excellent review of the kidney. In renal physiology attention continues to be focused on the use of clearance methods for the measurement of glomerular filtration rate, renal blood flow and tubular activities. The concept of competition for secretory and reabsorptive mechanisms in the renal tubules has proved very fruitful. The use of *p*-aminohippurate, which competes with penicillin for a secretory mechanism and so reduces urinary loss of penicillin during therapy, is an important practical outcome. Perhaps the most striking advances are in the review of the lymphatic system, where O. Cope and L. Rosenfeld deal with the relation of endocrines to the lymphatic system, the remarkable changes which occur in the 'alarm reaction' of Seyle, and the pituitary-adrenal control of the release of protein from the lymphocytes. In metabolic functions of the endocrine glands, E. W. Dempsey confines himself to certain new aspects of endocrinology, notably the relation of hormones to enzymes, hormone inhibitors and hormone antibodies. In physiological psychology, R. H. Seashore prefaces his survey of current literature with a general account of the principles and problems of this subject, for which the ordinary physiologist will be very grateful. In pharmacology, M. L. Tainter, L. C. Miller and T. J. Becker have concentrated on enzymes, dealing with the action of drugs on enzyme systems and the all-important subject of substrate competition. A short review of shock by M. I. Gregerson presents the considerable changes in outlook which have resulted from the Second World War and provides a most intelligible account of this difficult subject. Other subjects reviewed are effects of ultra-violet radiation, physiological aspects of genetics, and audition.

It is interesting to observe that most of the advances in fundamental physiology during the past two years have arisen directly or indirectly from the war-time study of problems in applied physiology.

O. A. TROWELL

CHROMATOGRAPHY FOR BEGINNERS

An Introduction to Chromatography

By Dr. Trevor Illtyd Williams. Pp. xi+100+8 plates. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1946.) 10*s*. net.

A BOOK that states its objective in the preface, and that precisely fulfils it in ninety-six crisply written pages, must be warmly commended. The objective, though limited, is worthy—"to provide a readable and descriptive account of chromatography", primarily for university students. Unlike the two earlier books on the subject, the first by Zechmeister and Cholnoky (translated by Bacharach and Robinson), the second by Strain, this one makes a deliberate selection of the available material, instead of presenting the lot in bewildering completeness. The result is a reasonably well-balanced account, with the emphasis upon technique and potentialities rather than upon past achievements. The reviewer was pleasantly surprised to find one after another of his pet tricks of technique described, until there was little left to quibble about. The frequent cross-references to other pages will also be very useful to a student using the book as a guide to practical work. Moreover, the author has not been content to select his examples from the older literature; for example, a whole chapter is devoted to the elegant techniques of partition chromatography on damp silica, starch, or strips of filter-paper, developed since 1941 by Martin, Synge, Gordon and Consden.

The chief criticism to be made of the book is that scarcely any indications are given of the capacities of adsorbents until Chapter 8, where most of the examples concern columns very much larger than students would normally employ. It would have been more helpful to include experimental details for a short series of practical exercises. Besides being of direct value to the student, these would have served as useful guides to the research worker needing to attempt similar separations. The point might have been made that only the powerful adsorbents will hold as much as 1 per cent of their own weight of adsorbed material—which is of great advantage in micro-analysis but a nuisance in preparative work. Another practical tip worthy of mention, even in an elementary text-book, is the advantage usually to be gained in sharpness of separation by applying the solute in fairly concentrated rather than dilute solution; also the value of *short* columns of alumina or charcoal—on Buchner funnels even—for removing the most strongly adsorbed component from a mixture, notably tar from organic preparations.

Dr. Williams deplores the term 'chromatography'. However, it is far too late to change it now, and after all it is a nice colourful word, descriptive either directly or indirectly of much of the art. For if the substances to be separated are initially colourless, one does one's best to get colours from them by putting indicators on the column (partition chromatography of acids; quenching of fluorescence by adsorbed substances), by viewing the column in ultra-violet light, or by applying colour reactions to eluates or to the column itself (streak method). In any event, the author's alternative, 'adsorption analysis', at once excludes what promises to become at least as important, namely, partition chromatography. If we really need a new term it should be one that emphasizes the *principle* involved in these separations on columns, namely, the repeated equilibrations of successive elements of one phase with successive elements of another, as in the analogous liquid-vapour fractionating columns. Authors of text-books on chromatography might not then turn a blind eye to another subject that should legitimately be included, namely, the manifold uses of natural and synthetic ion-exchange materials.

To extract materials from a column Williams 'elutes' it, whereas Strain felt obliged to 'elutriate' it. Williams (in conformity with the English translation of Zechmeister) calls the eluting agent the 'eluent'; in this instance, and for no logical reason, I prefer the American variant 'eluant'.

E. LESTER SMITH

Selected Topics from Organic Chemistry

By Dr. D. D. Karve and G. D. Advani. Pp. iv+284. (Poona: Dastane Brothers, 1945.) 8 rupees.

THIS book attempts to cover a wide field of organic chemistry in a small space, and much of the information contained in it is very condensed; the evidence for the structures of terpineol (p. 46) and carotene (p. 116), for example, is given too briefly to be of value. In a discussion of the Beckmann transformation the authors mention that it is used for determining the configurations of oximes and correctly show the trans-interchange, but givo no reason for this, nor any comment on the fact.

In certain cases the choice of material is peculiar; a chapter on "Some Important Condensation Reactions" starts with the Pechmann condensation and continues with the Fries reaction Dealing with the structure of benzene it is stated that the hydrocarbon can be reduced successively to C_6H_8, C_6H_{10} and C_6H_{12}, and Kekulé's formula is 'proved' without any mention of resonance; nor, for that matter, is resonance mentioned in discussions of colour and constitution, tautomerism or free radicals.

Many misstatements of fact appear: it is stated that citral gives acetone, carbon dioxide, water and lævulic acid on oxidation, and no mention is made of any oxalic acid. The following are quotations: "A compound, even though it may contain asymmetric groupings, is optically inactive if it has a plane or an axis of symmetry" (p. 7). "Due to the introduction of a new asymmetric carbon atom it is possible to account for a reactive hydrogen atom . . . [in glucose]" (p. 10).

"Claisen's condensation. Two molecules of an ester or an ester and a compound having a CH_2 group in proximity to a CO or CN group condense to form β-ketonic esters or β-ketones" (p. 237).

"In many cases, the crystallization of a racemic compound can be brought about in such a way that the two active modifications form separate crystals" (p. 244).

"The solution of sodium nitrite is then made up to exactly N/2 by adding the calculated amount of water or sodium nitrite" (p. 267).

Statements such as these rather tend to shake one's confidence in the accuracy of the information in general. F. B. KIPPING

An Introduction to Electronics

By Prof. Ralph G. Hudson. Pp. x+97+37 plates. (New York: The Macmillan Company, 1946.) 15s. net.

THE spectacular results of the release of nuclear energy from the atom have certainly caused the general public, not merely the scientific workers, to ponder deeply, and, if for this reason alone, this book will be welcomed. It deals only with one phase of atomic structure, namely, the electron and its applications, though there is one useful chapter on the constitution of matter generally.

The author suggests that the science might have been called 'protonics' or 'neutronics' instead of 'electronics', but in the reviewer's opinion the correct title has been used. So much is known about the electron that it can almost be regarded as an old friend; but there is much yet to learn about the proton and the neutron, especially how these constituents of the atom will interact under all conditions.

The subject is developed in a very logical way, and the matter is expressed in terms easily understandable by the reader who is prepared to go slowly and concentrate. It is up to date and gives a clear knowledge of the properties and control of the electron, which is regarded as the most active ingredient of matter, and it describes and illustrates many electronic devices used in industry and elsewhere. It is well written and splendidly illustrated with a profusion of most interesting plates.

The author concludes, "Electrons are the happy and faithful slaves of every man". The general public will perhaps be relieved when this remark can apply to the whole realm of atomic energy.

Nucleonics

What Everybody should know about Atomic Physics, Pp ii+38. (Washington, D.C.: Progress Press, 1946.) 1 dollar

THIS little book, of anonymous authorship, deserves a better title. It goes well beyond what is likely to appeal to the non-scientific reader who is interested by the practical applications of nuclear physics, and though it is clearly not intended for the serious student, he will find it interesting and sometimes illuminating

It consists mainly of a clearly written and well-illustrated account of some of the phenomena and instruments of nuclear physics, leading to a description of the principles of fission piles and 'atomic' bombs; a large amount of information is contained in small compass, and though the order of presentation is unconventional, the main principles are well expounded. There are misconceptions and slips that would not pass a physicist's scrutiny, and the references to people and dates are often misleading, quite apart from, an understandable concentration on American developments. A piece of fiction concerning Prof. Bohr on p. 29 is better not quoted!

Considered, however, as a frankly popular work, it is of refreshingly high standard compared with the mushroom growth of cheap books that, particularly in the United States, have sought to exploit public interest in atomic energy.

A Naturalist on Lindisfarne

By Richard Perry. Pp. 248+16 plates. (London: Lindsay Drummond, Ltd., 1946.) 15s.

OFF the Northumberland portion of the coast of England lies the island of Lindisfarne, also the smaller islands known as the Inner and Outer Farnes, all the haunt of sea-birds, much frequented by winter visitors and a halting-place for passing migrants. So St. Cuthbert found when he was appointed prior in 673, his special care being the eider ducks, which to this day are known as St. Cuthbert's ducks. Mr. Perry, wending his way some 1200 or more years later over the sands that separate Lindisfarne from the mainland, to take up his residence on the Holy Island, found himself in what was little short of an ornithological paradise. In this book he tells us of the island and its life, of the changing seasons, of the comings and goings of the bird population, with many observations on details of behaviour, including a chapter on the fulmar petrel with special reference to the homing of this species, which he records as visiting its nesting ledges in December. His appendix of the chronological history of the colonization of Holy Island by the fulmar embodies useful data, and another appendix is a painstaking list of the birds of Holy Island. FRANCES PITT

SIR THOMAS MORE AS PUBLIC HEALTH REFORMER*

By SIR ARTHUR S. MacNALTY, K.C.B.

SIR THOMAS MORE was a great forerunner of Edwin Chadwick in public health reform. More is renowned as saint and martyr; he was an eloquent orator, an eminent statesman and legislator, Speaker of the House of Commons, royal ambassador and Lord Chancellor, a master of English prose, and a classical scholar. These great gifts united in one man, in the very blaze of their glory have obscured Sir Thomas's teaching and work in public health and social medicine.

Thomas More (1478–1535), son of Sir Jonn More and Agnes Grainger, was educated at St. Anthony's School in Threadneedle Street, and brought up in the household of Thomas Morton, Archbishop of Canterbury and Lord Chancellor. During 1492–94 he was an undergraduate at Canterbury Hall, Oxford, where he came under the influence of the Humanists, Linacre and Grocyn. In 1496 he became a member of Lincoln's Inn and was called to the outer Bar in 1501. Dean Colet was his spiritual director. He met Erasmus in 1499—the beginning of a life-long friendship.

In 1501, at Grocyn's invitation, More lectured in the Church of St. Lawrence Jewry on St. Augustine's "de Civitate Dei". The lectures were historical and philosophical, and possibly criticized the social evils of the time. The chief and best-learned men of the City of London came to hear him.

The Influence of Linacre

We know that Thomas More read Aristotle, for he speaks of attending Linacre's course on the Meteorologica[1]. This study must not only have trained Thomas in politics, ethics and political economy, but also probably interested him in biology and natural history. In Holbein's portrait of More and his family, the artist has sketched in a small monkey beginning to climb up Lady More's dress. Further evidence of More's love of animals is obtained from Erasmus, who wrote of him[2]:

"One of his great delights is to consider the forms, the habits, and the instincts of different kinds of animals. There is hardly a species of bird that he does not keep in his house, and rare animals, such as monkeys, foxes, ferrets, weasels and the like."

The interest in natural history, as often happens, was associated with an interest in medicine and public health, and it is scarcely an assumption to say that More derived this from his Greek tutor, Thomas Linacre (1460–1524), who was equally renowned as physician and classical scholar. Linacre is, of course, famous for the large share he took in elevating the standard of medical education and in the foundation of the Royal College of Physicians in 1518, of which he was the first president. He founded medical lectureships bearing his name at Oxford and Cambridge, for which it is interesting to note that Sir Thomas More, Tunstall, Bishop of London, and two other persons were appointed trustees.

Linacre wrote several grammatical works and translated Galen into Latin. Erasmus mentions other completed works laid up in Linacre's desk, unpublished. It is not improbable that one or more of these lost works dealt with public health, for both Linacre's pupils, Sir Thomas More and Sir Thomas Elyot, were interested in the preventive aspect of disease and the preservation of health. We can reasonably surmise that More learned much from Linacre, and that this teaching led him to become a pioneer in public health administration.

More's Interest in Medicine

In the sixteenth century, the study of Greek not infrequently led on to that of medicine, and Thomas More encouraged this departure in his own household. The house at Chelsea was always full of scholars and pupils. Nicholas Kratzer, Henry VIII's astronomer, was a frequent visitor, as were Erasmus and other scholars from overseas. More believed in the higher education of women, and his daughters were liberally educated. Erasmus wrote to Ulrich von Hutten in the letter to which previous reference has been made:

"I should rather call his house a school, or universitie of Christian religion, for there is none therein but readeth or studieth the liberall sciences; their speciall care is pietie and vertue, there is no quarelling or intemperate words heard, none seen idle, which household that worthy gentleman doth not govern by proude and loftie words, but with all kind and courteous benevolence: everybody performeth his dutie; yet is there always alacratie; neither is sober mirth anie thing wanting."

There are at least three instances of members of More's learned household studying medicine. The first is Margaret Gigs, the foster-sister of More's daughter Margaret, who was to him "as dear as though she were a daughter". She was a Greek scholar, fond of mathematics and studied medicine. More relates, in the "Second Booke of Comforte Agaynste Tribulacyon", that when he lay in a tertian fever, symptoms arose which baffled his two physicians, but Margaret Gigs, then a young girl, identified the condition in Galen's "de differentiis febrium". More made Margaret Gigs his almoner for his outdoor charities, and she married Dr. John Clement, More's pupil, whom she had known from a child, and helped him in his medical work and classical studies. Clement became Wolsey's lecturer in rhetoric at Oxford, then professor of Greek, and was president of the College of Physicians in 1544[3].

More's third medical protégé was Richard Hyrde. He was tutor to More's children, and when Margaret Roper translated Erasmus's "Treatise on the Pater Noster", Hyrde contributed an introduction in English which justified the right of women to a scholarly education. Hyrde's study of Greek authors attracted him to medicine. As physician he accompanied Bishop Gardiner on his embassy to the Pope in 1528, and died of a chill.

More's writings contain many illustrations and comparisons drawn from his medical knowledge. This is strikingly exemplified in his unfinished treatise, "De Quatuor Novissimis", "The Four Last Things", written in 1522, when he had just been knighted and was under-treasurer. It is a meditation on death, and he describes the book as "a short medicine, containing only four herbs, common and well known, that is to wit, death, doom, pain and joy".

"For what would a man give for a sure medicine that it should all his life keep him from sickness,

* Abstract of a Chadwick Public Lecture given at the Royal Society of Tropical Medicine and Hygiene on October 8, 1946.

namely, if he might by the avoiding of sickness be sure to continue his life one hundred years."

In Sir Thomas's last book, "A Dyalogue of Comforte Agaynste Tribulacyon", written in 1534 when he was imprisoned in the Tower of London, there are again many instances culled from the author's medical lore.

In his keen observation, in his reflexion and deductions, and in his dislike of over-drugging, More had all the endowments of a wise physician. It is apparent that he would have been a great one if he had chosen medicine as his profession. Evidently he was intensely interested in medical studies and in the art of healing.

Commissioner of Sewers

In 1510, More was appointed one of the Under-Sheriffs of the City of London, which gave him opportunity to advise the Corporation on sanitary reform. This interest in public health was further shown by his appointment in 1514 as one of the commissioners of sewers along Thames Bank between East Greenwich and Lambeth.

The improvement of London's water-supply was much in More's mind when he described the river of Anyder, on which Amaurote, the chief city of Utopia, was situated, for Anyder, like the Thames, is a tidal river.

Throughout his career More, despite the claims of high office, continued with his work for the improvement of England's water-supplies. In 1526 he was again appointed commissioner of sewers for the coast of the Thames, from East Greenwich to Gravesend, and, as Lord Chancellor, he probably initiated the important Act of Parliament (23rd Hen. VIII, C.5), which appointed commissioners of sewers in all parts of the kingdom.

"Utopia"

"Utopia" was partly written at Antwerp, when More was ambassador to the Archduke Charles, afterwards Charles V, in 1515, and was completed in England. "Utopia" is 'No-Where', the imaginary Commonwealth of the Renaissance idealists. It advocates many social reforms; in addition, it devises a most complete system of health reform which was greatly in advance of his time, and in some respects in advance of our own time.

More envisaged a well-built city with gardens and open spaces, a public water-supply, drainage and cleaned streets, with public abattoirs outside. Public hospitals were provided for the treatment of rich and poor, and isolation hospitals for cases of infectious disease. Other amenities included communal meals, the safeguarding of maternity with municipal nurses for infant welfare, nursery schools (or crèches) for children under five, free universal education for all children, with continuation, adolescent, and adult schools; religious instruction, industrial welfare, enlightened marriage laws and eugenic mating, and obedience to the laws of health, including fresh air and sunlight, and active occupation without undue fatigue. It is a comprehensive programme of social medicine which, written in the sixteenth century, expresses many of the aspirations of to-day.

Interest in Care for the Sick and Infirm

More's interest in medicine and the prevention of disease were joined with a kind and charitable heart, which was touched by all forms of human suffering. This is revealed in the words of Thomas Stapleton, whose "Life of More" appeared in 1588.

"More was used, whenever in his house or in the village he lived in there was a woman in labour, to begin praying, and so continue until news was brought him that the delivery had come happily to pass.

"The charity of More was without bounds, as is proved by the frequent and abundant alms he poured without distinction among all unfortunate persons. He used himself to go through the back lanes and inquire into the state of poor families; and he would relieve their distress, not by scattering a few small coins, as is the general custom, but when he ascertained a real need, by two, three or four gold pieces.

"When his official position and duties prevented this personal attention, he would send some of his family to dispense his alms, especially to the sick and the aged." This office, as already mentioned, was frequently performed by Margaret Gigs. "He very often invited to his table his poorer neighbours, receiving them . . . familiarly and joyously; he rarely invited the rich, and scarcely ever the nobility. Not a week passed without his taking some poor sufferer into his house and having him tended. In his parish of Chelsea he hired a house, to which he gathered many infirm, poor and old people, and maintained them at his own expense. When More was away, his eldest daughter, Margaret . . . had the care of this house.

"He even received into his household and supported a poor widow named Paula, who had spent all her money on a lawsuit."

The relief of the destitute and care of the sick were largely in the hands of the religious houses, and it was not until after the dissolution of the monasteries that the poor became a State problem, necessitating Poor Law legislation. More, in his wisdom and humanity, would have devised a sound system of Poor Law relief. The Poor Law legislation of Henry VIII and Edward VI put the onus of relief on the charity of local districts, and the problems of unemployment and destitution were not handled effectively until the celebrated Poor Law Act of Elizabeth in 1601.

More as a Health Administrator

There was much epidemic disease in Tudor times. Outbreaks of typhus fever appeared in Europe and began to be frequent in the towns and overcrowded gaols of Britain. Typhoid, dysentery and malaria were endemic. Sir Thomas himself suffered from a tertian fever. Creighton notes an epidemic of influenza in 1510. The deadliest epidemics were plague and the 'sweating sickness'. During 1511–21 there is not a single year without some reference in the letters of Erasmus and elsewhere to the prevalence of plague.

The sweating sickness was one of those mysterious maladies, like influenza and encephalitis lethargica in our own time, which suddenly appear, wreak havoc and destruction for a time, and then as suddenly disappear. The disease was first noted in August 1485, and was also brought to England in the army of Henry VII, which landed at Milford Haven[4]. It spread to London, where it caused great mortality. Sweating sickness has been identified by Dr. Creighton, the epidemiologist, and Dr. Michael Foster with 'miliary fever' (*schweissfriesel, suette miliaire*, or 'the Picardy Sweat'), a malady repeatedly observed in France, Italy and south Germany, but not in Great Britain. It was characterized by intense sweating and an eruption of vesicles, lasted longer than sweating sickness, occurred in limited epidemics, and was usually not fatal. The first epidemic was seen in 1717 and it continued to 1906, and even later. Dr. Michael Foster and Sir Henry Tidy saw cases of the disease in France during the First World War[5].

In the summer of 1517, London was visited by a virulent outbreak of the disease, which spread by the following year all over the country, and especially in the crowded towns. Colet succumbed to the infection, Wolsey had more than one attack, and Andreas Ammonius, Henry VIII's Latin secretary, died of it.

More noted the danger of relapse in sweating sickness. "Considering there is, as physicians say, and as we also find, double the peril in the relapse that was in the first sickness "[6]

Plague was also prevalent, and the diseases terrified King Henry, who fled from London to Windsor, and thence to Abingdon. In April 1518, both plague and sweating sickness were rife in Oxford. The King appointed More, who had returned from the embassy to Calais, to supervise the health measures to be taken in this emergency. On April 28, Master More certified from Oxford to the King at Woodstock that three children were dead of the sickness, but none others; he had accordingly charged the Mayor and commissary in the King's name "that the inhabitants of those houses that be and shall be infected, shall keep in, put out wispes [of hay] and bear white rods, according as your Grace devised for Londoners". They were also forbidden to keep animals in their houses, and officers were required to keep the streets of the town cleansed and to burn refuse.

Here we see notification and segregation used for the prevention of epidemic disease, and Thomas More controlled it by these means. The King's Council approved these measures, and in June 1518, Pace wrote from the Court at Woodstock to Wolsey that "all are free from sickness here, but many die of it within four or five miles, as Mr. Controller is informed".

On July 18, More wrote:

"We have daily advertisements here, other of some sweating or the great sickness from places very near unto us; and as for surfeits and drunkenness we have enough at home."

In the severe outbreak of 1528, More's daughter, Margaret, nearly succumbed to the sweating sickness. Anne Boleyn was attacked by it, and her royal lover hastily left her for several weeks.

More's excellent sanitary regulations, no doubt, helped to prevent more widespread infection and to diminish the virulence of these pestilences. The first plague order was issued in the thirty-fifth year of Henry VIII, in 1543, and, as Creighton remarked, contains the germs of all subsequent preventive practice. More had then been dead for eight years, but the order codified his previous regulations and instructions. Instead of wisps of hay, the sign of the cross is to be set on every house which might be afflicted with the plague, and there continue for forty days. Segregation, disinfection—chiefly by burning straw pallets, etc., and scouring—and the bearing of white rods by plague contacts are enforced, and this additional humane regulation breathes the spirit of Thomas More: "That no housekeeper should put any person diseased out of his house unless they provided housing for them in some other house."

The more one delves into State papers of the time of Henry VIII, the more one reads Sir Thomas More's books, treatises and letters, and studies the account of his work in the letters of Erasmus and other contemporaries, the more one marvels at his wisdom and his outlook upon hygiene and public health.

Hospital Reform

This admiration for More is further enhanced when we examine his views on hospitals. He was a protagonist of hospital reform. In "Utopia" he sets forth a hospital scheme in these words:

"For in the circuite of the citie, a little without the walls, they have iiii hospitalles, so bigge, so wyde, so ample and so large, that they may seme iiii little townes, which were devised of that bignes partely to thintent the sycke, be they never so many in numbre, should not lye to thronge or strayte, and therefore uneasely and incommodiously · and partely that they which were taken and holden with contagious diseases, suche as be wonte by infection to crepe from one to another, myght be layde apart farre from the company of the residue. These hospitalles be so wel appointed, and with al thinges necessary to health so furnished, and more over so diligent attendaunce through the continual presence of cunning phisitians is geven, that though no man be sent thether against his will, yet notwithstandinge there is no sicke persone in al the citie, that had not rather lye there then at home in his owne house."

Sir Thomas More, when he wrote on theological or religious subjects, was often prolix, but in this account of the best form of hospital, its amenities and advantages, he is wonderfully concise Yet all the points are there: situation, provision for all sick persons, proper furnishing and equipment, medical specialists in regular attendance, everything indeed that we are now endeavouring to obtain for the sick in the middle of the twentieth century.

In his "Supplication of Souls in Purgatory" (1529), written as a counter-blast to Simon Fish's "Supplication of the Beggars", More demonstrated the folly of abolishing the hospitals. He alludes to the benefits they conferred in diminishing the amount of sickness among the destitute, appreciates the value of case-records and statistics, which were lacking in the case under consideration; but, nevertheless, considers that the number of the sick through hospitals are less than in times past, and cites the French pox:

"And then of the french pockes thirty year ago went there about sick five against one that beggeth with them now. . . . As for other sickness the incidence is not greater than in times past."

In his cupidity and lack of humanity for his necessitous subjects, Henry VIII ignored More's wise counsel. The hospitals were suppressed, and the "Five Royal Hospitals" of London, including St. Bartholomew's and St. Thomas's Hospitals, were only preserved through the public-spirited action of the Corporation of London.

Conclusion

More succeeded Wolsey as Lord Chancellor, but he resigned in 1532, as he disagreed with the King's ecclesiastical policy. In 1534 he was imprisoned in the Tower, indicted for high treason in 1535, found guilty on perjured evidence, and executed on Tower Hill, "the blackest crime ever perpetrated in England under the form of law".

Sir Thomas More, as we have seen from "Utopia", devised a most complete system of health and social reform which was greatly in advance of his time, and in some respects in advance of our own time. His fame as public health reformer, therefore, rests more on planning and prophecy than on achievement. He was, however, a great administrator, and reference has been made to his practical measures as commissioner of sewers in regard to water-supplies and to his distinction in initiating the control of epidemic disease and plague. Had England then been ruled by an enlightened monarch, interested in the welfare of his subjects, public health reform would have been inaugurated on wise lines in the sixteenth century, for Sir Thomas had the root of the matter in him.

[1] Ad Dorpium, "Lucubrationes" (1563), 417.
[2] Letter to Ulrich von Hutten, July 23, 1519
[3] Munk, W., "The Roll of the Royal College of Physicians of London" (1878) vol 1 25. Wenkebach, E., "John Clement ein englischer Humanist und Arzt des sechzehnten Jahrhunderts Sudhoff's "Studien zur Geshichte der Medizin", Heft 14 (Leipzig, 1925).
[4] See Forrestier, T, British Museum, Addit MS, No 27,582, and Creighton's "History of Epidemics in Britain", vol 1, 237.
[5] *Brit. Med. J.*, ii, 63, 196 (1945).
[6] "The Pitiful Life of King Edward the Fifth" Camelot edition, p 230.

MOSAIC DISEASE OF THE NARCISSUS

By Dr. JOHN CALDWELL
University College, Exeter

THE problem of 'mosaic' or 'stripe' disease of *Narcissus* has interested growers and others for some considerable time Recently much work has been carried out on the disease in the United States by Haasis, in Holland by van Slogteren and his colleagues, and in Great Britain by Caldwell and his colleagues. Though not all the details have been worked out, some clear-cut conclusions have been arrived at, and it seems worth while taking stock of the present position.

In the first place, it is now quite clear that the group of diseases commonly called 'stripe' or 'mosaic' in *Narcissus* is caused by a pathogen of the virus group. In the laboratory the disease is readily transmitted by grafting a part of a diseased bulb on to a part of a healthy one, when the healthy bulb is then infected. It is also readily transmitted by rubbing the leaves of a healthy plant with juice extracted from a diseased plant. Infection is increased by the use of carborundum powder with the inoculum. The powder has the effect of rupturing the cells of the leaves without doing extensive damage to the tissues. Virus agents in general cannot enter an unbroken cell, nor, on the other hand, can they develop in a cell which is very badly damaged. One of the difficulties which has been encountered by all workers on *Narcissus* mosaic is that the disease symptoms are not shown by a treated plant in the same season as the inoculation is made. In other words, one has to wait for nearly a year before one can tell whether infection has taken place, so far, at least, as appearances are concerned. A laboratory method which does shorten the time required to ascertain if infection has taken place is by precipitin tests.

In the field the disease is clearly transmitted by the transfer of the virus agent in infective juice by the agency of sucking insects. A great deal of work on this aspect of the subject has been carried out because, obviously, in commercial holdings infection must take place by natural means. It is considered improbable that much, if any, transmission of the disease agent takes place by the normal methods of cultivation or of cutting flowers and so forth. Haasis, in a short note, has reported that four insects are disease vectors in the United States, and van Slogteren has listed three for Holland, namely, *Aulacorthum solani* (*Myzus pseudosolani*), *Doralis* (*Aphis*) *rumicis* and *Macrosiphum euphorbiæ* (Thomas). *Myzus persicæ* (the peach aphis), a common vector of many virus agents, he found not to be a vector for the virus of *Narcissus* mosaic. We in this Department have been unable, so far, to induce any insect under experimental conditions to transmit the disease, and, in point of fact, few insects seem to be common on the *Narcissus*. Curiously enough, no direct evidence has yet been produced by any worker that the mite *Tarsonemus approximatus narcissi* (Banks), which is so common on the *Narcissus*, is a vector of the agent. We are satisfied, however, that some insect is, in fact, the vector under field conditions. We grew blocks of *Narcissus* made up of groups of healthy and of diseased plants of the variety 'Sir Watkin', which, incidentally, has been selected quite independently by all workers as their experimental material. Some of the blocks were separated one from another by wooden frames sunk some feet into the ground to prevent any contact between the roots. In others the roots could freely grow together, but the plants were sprayed from time to time during the growing season with a nicotine spray to kill any insects on the foliage and to discourage insect visitants. Plants in the square of healthy plants, which were isolated from the diseased plants by the wooden frame, were found ultimately to be infected to the extent of thirteen out of sixty-eight, while only two of the sixty-four bulbs in the sprayed block were infected after the same period. This was taken to indicate that spread takes place by the agency of some vector on the foliage and not through the roots, as was suggested by McWhorter some years ago. This conclusion, that is, of aerial rather than root infection, is supported by the work of Haasis and of van Slogteren.

Another difficulty in experimenting with *Narcissus* mosaic is that under certain conditions, notably in the higher temperatures of the early summer or such as obtain in glasshouses, there tends to be 'masking' of the symptoms. This means that plants, the foliage of which show marked symptoms of disease in the colder weather of early spring, may appear almost healthy in the warmer days of early summer. We have a variety of *Narcissus* which develops a most markedly chlorotic leaf when infected. We have found that it is possible, by keeping the plants in pots and exposing them alternately to high and to low temperatures, to induce the leaves to develop alternate green and yellow bands running horizontally across them—a 'zebra' effect.

The existence of 'masking' by temperature and possibly by other environmental conditions necessitates the greatest care in the selection of bulbs to ensure that only really healthy bulbs are used for experimental material. We rogue our healthy 'Sir Watkin' stock rigorously and have watched them for some years before using them as experimental material.

The disease is not seed-transmitted. We have grown many thousands of seedlings from seeds which were obtained from virus-infected plants—pollen parent diseased, seed parent diseased, and both parents diseased—and in not a single instance have we found the seedlings diseased ; nor have the plants afterwards shown symptoms of disease when grown in isolation. This ensures, at least, that breeders and raisers can always begin with healthy stock—unlike, of course, those who propagate varieties by bulbs—and it would obviously pay all raisers of new varieties to take the greatest possible care to ensure that their seedling plants are grown as far away as possible from infected plants.

It is clear that some varieties of *Narcissus* are less affected by the disease than others, and that some varieties continue to flower and to flourish, if perhaps not so well as they might, at least sufficiently well to satisfy the not too-exacting grower. Other varieties, on the other hand, are so crippled by the disease that the plants become progressively smaller and smaller, cease to flower, and may actually 'starve' themselves out of existence. In many of the yellow varieties the flowers are flecked with white or lighter yellow areas, and may even be distorted. Distortion also of the flower-stalk spoils the flower from the gardener's or the commercial grower's point of view It is now almost certain that there is only one virus agent which causes all these apparently different types of disease, and the difference in symptom-expression is a varietal difference, not a difference in the agent. We have found, for example, that juice from a diseased 'Sir Watkin' plant inoculated into a 'Croesus' plant causes the typical symptoms found in 'Croesus'. Inoculum from 'Croesus' into a healthy 'Helios' plant induces 'Helios' symptoms, and a back-inoculation from the diseased 'Helios' plant induces typical 'Sir Watkin' symptoms in a 'Sir Watkin' plant, and so on. It is clearly essential, therefore, that any suspected plants of all varieties should be 'rogued' as soon as they are noticed, since they will act as sources of infection for other varieties which may be much more susceptible to the disease than are the original diseased plants. This question of susceptibility to disease is one in which much help might be obtained from the grower and especially from the raiser of *Narcissus*. It is quite clear to us, as it must be to anyone who has had occasion to make similar observations, that some varieties are quickly reduced to uselessness by mosaic disease while others are only slightly affected, others again occupying an intermediate position. Clearly this susceptibility must be connected with the hereditary make-up of the variety, and any observations on these points would be most helpful. For example, *Narcissus jonquilla* and its hybrids, in our experience, are apparently little affected by the disease and show very slight symptoms, as also do the *N. poeticus* varieties. *N. triandrus* hybrids, or at least some of them, seem to be very susceptible, and so forth. Incidentally, I have not so far found a single case of mosaic in a plant of the wild *Narcissus pseudonarcissus*, though I have carefully examined many thousands of plants.

As more information becomes available about the nature of the disease, further methods of control may suggest themselves. In the present stage of knowledge, the most effective method is obviously careful rogueing of the stocks. Periodic inspections should be carried out and suspected plants should be removed and burnt. Clearly, inspection should begin early in the growing season before there is a likelihood of 'masking' of symptoms by higher temperatures. In small plantings, additional protection could be afforded by spraying with an insecticide like nicotine. Haasis has suggested that some measure of control might result from the selection of the larger bulbs from a group grown under similar conditions, as the effect of the disease is to reduce the bulb size appreciably. That reduction of size is found in diseased bulbs we have also found, but obviously this method would be only partially effective. Raisers of new varieties should remember that the seedling plants are always healthy, as the disease is not seed-borne, and great care should be exercised in growing new stocks as far away as possible from stocks of diseased bulbs if the latter must not be destroyed.

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SOCIAL MEDICINE AT OXFORD

IN a letter to Fulgenzio, Francis Bacon remarked that "the instauration of the sciences require some ages for the ripening of them". Social medicine may, in some respects, be regarded as an "instaurated', or "renewed" science, for it is one of broad outlook and revives the philosophical attitude with which the Greeks approached the study of social problems and natural phenomena. It is one of the most comprehensive of sciences, calling to its aid many branches of knowledge in the elucidation of its problems. It is fitting, therefore, that the first chair and Institute of Social Medicine have been established at Oxford, a University rich in many founts of learning, including the activities of Nuffield College, which is conducting important investigations into social problems. The University was exceptionally fortunate in securing for its first professor of social medicine so eminent a physician as Prof. John A Ryle.

The Institute came into being as from April 1, 1943, but, owing to war-time difficulties, its working life only began in the spring of 1944. Yet, as its first annual report shows, a comprehensive programme of work has been drawn up and a number of investigations are already in progress. Certain of these, as the list of publications indicates, have either been completed or have reached a stage which justifies a preliminary report.

The purposes of the Institute are as follows:

(*a*) To investigate the influence of social, genetic, environmental, and domestic factors on the incidence of human disease and disability.

(*b*) To seek and promote measures, other than those usually employed in the practice of remedial medicine, for the protection of the individual and of the community against such forces as interfere with the full development and maintenance of man's mental and physical capacity.

(*c*) If required by the University to do so, to make provision in the Institute for the instruction in social medicine of students and practitioners of medicine approved by the Board of the Faculty of Medicine in the University of Oxford.

A review of the activities of the Institute reveals that the investigations made conform closely with the above requirements. Several of these relate to the health of infants and children. One of the criticisms of the School Medical Service has been the number and variety of defects among school children. It has been pointed out in successive annual reports of the Chief Medical Officer of the Ministry of Education that these defects come to light chiefly when children are first examined medically on entrance to school. They develop during the pre-school age, and accurate knowledge concerning them is lacking. In 1944 the Institute launched a long-time survey to study and compare the health, development and sickness experience of children in all social groups from the first weeks of life to the age of five. The medical officer of health for Oxford City, his colleagues and the health visitors co-operate in this investigation, which should yield important results. A statistical analysis is being made of the still-birth rates and neo-natal rates in England and Wales in relation to environmental and social factors, and a special genetic study of twins is in progress.

The relationships between occupation and morbidity is another field in which extensive knowledge is lacking. Dr. W. T. Russell is making a statistical analysis of sickness absence at Morris Motors works, Cowley, including correlations of the main causes of sickness with such factors as age, sex, trade and season. On the basis of the initial study, it is hoped later to select particular causes of sickness, such as peptic ulcer and the chronic rheumatic diseases, for a more detailed inquiry into incidence and etiology. It is believed that certain useful analyses will emerge which should prove of ultimate advantage to the health of the workers, to the management and to production. When this inquiry extends to other industrial centres, comparisons of morbidity experience as between different industries, or between factories of the same industry in differently situated districts, should in time become possible.

On behalf of the Goitre Sub-Committee of the Medical Research Council, an extensive survey has been made on school-children at ages eleven to fifteen in several districts of England and Scotland to determine the varying incidence of thyroid hyperplasia in relation to the iodine content of drinking water. Significant variations in incidence have been demonstrated which correspond with variations in the amount of iodine present in the drinking water as well as with the varying incidence of childhood hyperplasia and adult goitre in the country. In the course of the survey a standard method of examining and recording the state of the thyroid gland was established.

Radiographic studies bulk largely in the report. They have been used in the investigations mentioned, and special inquiries are also being made to obtain more precise information on bony changes related to nutrition and intercurrent disease during the period of growth.

These important researches by no means exhaust the activities of the Institute. Its work is intimately connected with the Bureau of Health and Sickness Records in Hospitals (Nuffield Provincial Hospitals Trust). It has helped in investigations directed by the Ministry of Health and other official bodies, and has established itself as a consultative and advisory centre. It is responsible for the teaching of Oxford medical students in social and preventive medicine, and is extending its work in many directions.

Social medicine is an uncharted sea. The information in the present report reveals not only the possibilities of new discoveries, but also how well the work to this end is being directed, planned and organised.

ANATOMY OF THE PRIMARY VASCULAR SYSTEM IN DICOTYLEDONOUS PLANTS

By K. J. DORMER

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A STRIKING feature of botany as the science exists at present is the lack of any coherent body of comparative morphological doctrine dealing with the angiosperms. There are no books on the flowering plants in any way comparable with Bower's work on the ferns or Chamberlain's on gymnosperms. As a result, the treatment of angiosperms in university courses on botany is usually confined to separate and unrelated series of lectures on systematics and on plant anatomy. In seeking a remedy for this remarkable situation one cannot but be impressed by the almost complete neglect of the gross anatomy of the primary vascular system, or what the older anatomists called "the course of the vascular bundles in the stem". Analogy with the study of other groups suggests that this department of anatomy may be expected to yield data of phylogenetic significance The pioneer paper published by Nageli[1] in 1858 is still our principal source of information on this topic, the few memoirs which have appeared since that date being for the most part descriptions of the development of single species or accounts of the more obviously aberrant groups such as Piperaceæ. There have also been some publications dealing with the number of traces to a leaf in various families (for example, Sinnott[2]). The neglect of the subject may be attributed almost entirely to the fact that Nageli and nearly all subsequent writers have paid altogether too much attention to the supposed basipetal development of the leaf traces, and have described vascular systems in terms of traces running down the stem and joining on to the traces of older leaves. Descriptions framed in this way make very tedious reading, and are so ill-adapted to the comparison of related vascular systems as to be almost unintelligible without the aid of diagrams. Furthermore, such accounts tend to emphasize relatively trivial features, especially the numbers of internodes which the various bundles traverse, at the expense of others which are really far more important.

In some recent publications[3,4] I have therefore made a complete break with tradition and employed a terminology which is independent of ontogenetic considerations. A primary distinction has been established between 'open' vascular systems, in which the bundles, as they run upward through the stem, branch but do not anastomose, so that the foliar gaps are open for an indefinite distance upwards, and 'closed' systems, in which the foliar gaps are regularly closed by anastomoses of the bundles. An open system is shown in Fig. 1, where the stele is represented as having been cut open down one side and then laid out flat. Crosses denote the median traces of leaves and the small circles lateral traces. Examination of this diagram will reveal a property common to all open systems, namely, the segregation of the primary vascular tissue into a number of units (in this case five), which have no communication with each other except at the base of the shoot, and, in some cases, including the one illustrated, also through the leaves. In closed systems, on the other hand, as in that shown in Fig. 2, the primary vascular tissue

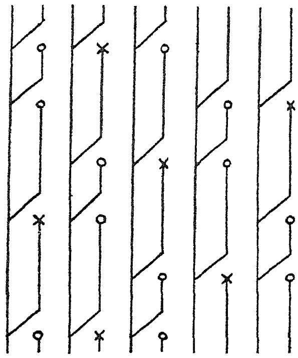


Fig 1 ACACIAN VASCULAR SYSTEM

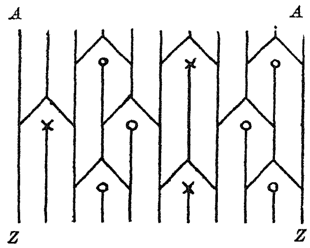


Fig. 2. VASCULAR SYSTEM OF *Medicago* sp.

forms a continuous network. (In this figure the bundle lettered *AZ* has been represented twice over.)

In view of the known physiological importance of xylem and phloem, it seems reasonable to suppose that the tangential discontinuity of these tissues in open systems would involve a certain degree of inefficiency. It is therefore of great interest that in all open systems so far investigated interfascicular xylem and phloem are present almost from the beginning. So far as it is possible to generalize from the very scanty data so far available, it appears that the condition so popular with writers of elementary text-books, where fully developed vascular bundles are separated by wide parenchymatous primary rays, can only exist in plants with closed vascular systems. As closed systems are almost certainly in the minority, the current conception of a typical dicotyledonous stem appears to require some revision.

Apart from a general tendency for the more specialized herbaceous families to display closed systems, there is no close correlation between the type of vascular system and the habit of the plant. Thus *Casuarina*, although woody, has a closed vascular system and a tardy development of interfascicular tissue, while many herbs have open systems and exhibit a continuous ring of xylem and phloem almost from the beginning. A herb of this type is to all intents and purposes a woody plant which never develops beyond the first annual ring, and should be clearly distinguished from those more typically herbaceous forms in which interfascicular tissues develop late (for example, *Helianthus*) or not at all (for example, *Petasites*).

Both open and closed vascular systems display great variety in phyllotaxy and in the number and position of the foliar traces. These differences offer a rich and unexplored field for the characterization of taxonomic groups. We are here concerned with matters of more general interest.

The particular type of open system shown in Fig. 1 appears to be of outstanding importance. The 'stem bundles', which are indefinitely continued upwards and which give rise to the traces as lateral branches, are here equal in number to the orthostichies of the regular spiral phyllotaxy, and each leaf has three traces, each lateral trace being separated from the corresponding median one by a single stem bundle. Any vascular system exhibiting these features may be called an 'acacian' system. (It should be noted that the concept of a 'stem bundle' is quite distinct from the 'cauline bundle' of the older anatomists.) The figure presents the acacian system in a somewhat idealized form. In reality, the length of the free course of a trace is subject to wide and random variation, nor is it a constant rule for the traces to depart from the stem bundles in one direction only. In a description written in the old style the essential features of the acacian system would be submerged beneath a welter of detailed information about the idiosyncrasies of individual traces.

Detailed evidence has been presented elsewhere[3,4] in support of the view that the acacian vascular system was the ancestral form for the Leguminosæ. This interpretation is based partly on the occurrence of acacian systems more particularly in those genera which are judged on grounds of floral structure to be primitive, but principally on the fact that acacian forms occur in many tribes which also have non-acacian representatives, the acacian forms in different tribes resembling one another much more closely than do their non-acacian allies. Any interpretation which does not regard the acacian forms as primitive involves the assumption of numerous convergent evolutionary trends, and is therefore to be rejected unless upheld by a considerable body of new facts.

It would be premature to attempt to extend this reasoning to the dicotyledons as a whole, but as a working hypothesis to act as a spur to further research the idea that the primitive angiosperm had an acacian vascular system has much to recommend it. At least, it does not conflict with any of the known facts, and in several instances it accords very well with the available data. Thus, for example, the Euphorbiaceæ are mostly acacian, the known exceptions being the specialized and quite dissimilar herbaceous genera *Ricinus* and *Mercurialis*.

It may reasonably be expected that of all woody dicotyledons with alternate leaves some 60–70 per cent will be found to have acacian systems, a large proportion of the remainder being derived from the acacian type by the omission of the lateral traces. Scarcely anything is known concerning the woody forms with opposite leaves, but it seems quite certain that among the herbaceous dicotyledons the vascular systems display such diversity that no type can be pointed out as being specially abundant.

Examination of Fig. 1 will show that the adjacent lateral traces of two successive leaves are on the same vertical line, so that the insertions of the leaves, as seen in a plan view of the shoot, would just meet. In such cases the insertions may be said to be 'in contact'. Other conditions also occur. In a considerable number of cases the insertions of successive leaves overlap, as seen in plan view ('interlocked' insertions), while in others they fail to meet ('separated' insertions). The interlocked condition of the insertions, though often a serviceable taxonomic character, does not appear to be of any great general interest. The separated arrangement, however, is closely linked with some problems of phyllotaxy.

In all the plants so far investigated in which the insertions are in contact, the spiral phyllotaxy is perfectly regular, both internode length and angular divergence being practically constant. This is also often the case when the insertions are separated. A number of cases are known, however, where separated insertions are associated with a more or less complete breakdown of the spiral leaf-succession In *Lespedeza sieboldi*, *Amorpha canescens*, and some species of *Erythrina*, shoots can be found in which the arrangement of the leaves appears to be governed solely by the consideration that two leaves cannot occupy the same position. In some instances indications of a verticillate arrangement can be found. Occasionally the whole transition from a spiral to a whorled (or decussate) arrangement may be found in a single species. Thus in *Spartium junceum* the plumular shoot has a spiral of leaves with the insertions, or at least the lower ones, in contact, while the lateral branches have separated insertions and decussate phyllotaxy. It appears that in some trees the normal shoots have insertions in contact and spiral phyllotaxy, while the suckers have separated insertions and tend to form whorls Although it is possible that whorls have also arisen in other ways, it seems probable that most verticillate phyllotaxy is merely a consequence of the separation of the insertions The prevalence of opposite leaves in so many families of Sympetalæ may well be due to the fact that each leaf has only a single trace, so that the insertions are necessarily separated.

It is now nearly ninety years since the appearance of the first important memoir on this aspect of plant anatomy, yet the subject is still in its infancy. During the last few decades there have been signs of an awakening interest in the morphology of the angiosperm shoot, and it is reasonable to hope that the primary vascular system will in future receive its fair share of attention.

[1] *Beitr wiss Bot.*, 1 (1858).
[2] *Amer. J. Bot*, 1, 303 (1914)
[3] *Ann Bot*, N S., 9, 141 (1945)
[4] *New Phytol*, 45, 145 (1946).

NEWS and VIEWS

Universities of the Argentine: Retirement of Prof. Bernardo A. Houssay, For.Mem.R.S.

THE Universities of the Argentine have at present lost their autonomy, the Government having placed at the head of each faculty an 'intervening delegate', who has taken over administration and direction in accordance with the Government's wishes. Basing his action on the recent decree of the executive power controlling clauses in the University statutes concerning the age limit for retirement of professors, the 'intervening delegate' of the Faculty of Medical Sciences in the University of Buenos Aires has informed Dr. Bernardo A. Houssay, titular professor of physiology, who has a world-wide reputation in the field of endocrine research, that he is now liable for retirement and is forthwith 'relieved of his post'. Dr. Houssay is fifty-nine years old. His forcible retirement was followed by a boycott by the students of the physiology classes, and many resignations of members of the staffs of Argentine universities, including Dr. E. Braun Menendez, Dr. V. Foglia, Dr. L. Leloir and Dr. J. T. Lewis.

It will be recalled that Prof. Houssay was relieved of his post some time ago by Government decree, but this action was afterwards declared illegal and Houssay was judged never to have left his university position. At that time an independent Instituto de Biologia y Medicina Experimental was founded at Calle Costa Rica 4185, Buenos Aires, with widespread financial support not only in the Argentine but also the United States of America and other countries, which was staffed by Dr. Houssay, Dr. Braun Menendez, Dr. Foglia, Dr. J. T. Lewis, Dr. O. Orias and others. When Dr. Houssay returned to his university post after his first dismissal, the Instituto de Biologia y Medicina Experimental was still maintained as an independent unit, and it is to be presumed that Dr. Houssay has now returned to the post of director of this Institute.

Economics at Leeds: Prof. J. Harry Jones

PROF. J. HARRY JONES has just retired from the chair of economics in the University of Leeds which he has held for the past twenty-seven years, and has been made emeritus professor. He has also been given the honorary degree of doctor of laws of the University of Wales. Prof. Jones has rendered outstanding services to the University of Leeds both as a leading authority in his subject and in the development of university policy, and has built up a strong Department of Economics and Commerce. Prof. Jones went to Leeds with the highest academic qualifications in economics from University College, Cardiff, and with valuable experience both of university teaching, at Liverpool and Glasgow, and of Government war-time work in the Ministry of Munitions and the Ministry of Labour. He thus brought to his work first-hand practical knowledge as well as great gifts of theoretical analysis. His outlook has been liberal, and in his teaching, writings and research he has maintained the highest standards of academic integrity.

Prof. Jones' work has received national recognition by his membership of Royal Commissions and Government committees, including the Royal Commission on the Geographical Distribution of the Industrial Population, and he was chairman of the Nova Scotia Royal Commission of Economic Enquiry in 1934. He has served on committees of the Economic Advisory Council, on trade boards, and on the West Riding Agricultural Wages Committee. The problems of finance have always been one of his main interests, and in this connexion he has maintained close contact with the professional organisations of bankers and accountants; he has also made a special study of the economics of the coal mining industry and of building societies, and has recently prepared a report on road accidents for the Government. Prof. Jones has contributed a number of papers to the Royal Statistical Society, has been a member of its council, and was awarded its Guy Silver Medal in 1934; he has also served as president of Section F of the British Association. His publications include books on "Social Economics" and "The Economics of Private Enterprise".

Imperial Institute of Entomology: Dr. S. A. Neave, C.M.G., O.B.E.

THE retirement of Dr. S. A. Neave last July from the directorship of the Imperial Institute of Entomology will be much regretted by entomologists and others in many countries He was appointed assistant director of the then Bureau of Entomology in 1913, and filled that position until July 1942, when he succeeded Sir Guy Marshall as director of the present Institute. Dr. Neave's name is inseparably associated with the growth and outstanding reputation of the Institute's Publication Office. In particular the *Review of Applied Entomology* and the *Nomenclator Zoologicus* (in four volumes) are constant reminders of the debt which not only entomologists but also general zoologists owe to Dr. Neave. In addition, during the four years he was director of the Institute, Dr. Neave supervised the production of the bulky "Insecta" part of the annual *Zoological Record*, besides editing the *Bulletin of Entomological Research*. He carries with him the good wishes of a wide circle of entomologists, and many others, on his retirement. He is succeeded as director of the Imperial Institute of Entomology by Dr W J. Hall, who was appointed assistant director in 1944 (see *Nature*, **153**, 649 ; 1944).

Astronomical Institute at Amsterdam : Prof. A. Pannekoek

THE Astronomical Institute of the University of Amsterdam has a unique reputation in the astronomical world as a centre for research in both stellar physics and stellar statistics This is due to the work of its first director, Prof. A. Pannekoek, whose retirement has just been announced (*Nature*, Nov. 9, p. 662). Noteworthy among his investigations was that which first established a wide dispersion in the absolute magnitudes of the hot, B-type stars, and so led to the now generally accepted view of the existence of these stars in highly localized clusters. Equally significant was his work on Saha's theory of thermal ionization and on the theory of stellar line contours. He is one of the three pioneers—McCrea and Unsöld being the others—responsible for developing a wholly deductive theory of the model stellar atmosphere, while his more recent spectroscopic work on the brighter Cepheids has already led to interesting developments in spectrophotometric technique.

Prof. H. Zanstra

PROF. PANNEKOEK'S successor as director of the Institute is Prof. H. Zanstra, well known in Great Britain as the first Radcliffe Travelling Fellow in astronomy. Zanstra's work has been inspired by a keen physical insight, and has led to the widely accepted quantitative theory of the luminosity of the gaseous nebulæ. Equally significant have been his investigations of the dynamics of radiation pressure in diffuse and planetary nebulæ, and his discussion of the probable expansion of the latter objects. In recent years his interest has been awakened in solar physics, and he has been responsible for investigations on the hydrodynamics of solar prominences and the polarization of resonance radiation from the limb of the sun. In Prof. Zanstra the Institute has a director who may be expected to maintain its great reputation.

Fourth Centenary of the Birth of Tycho Brahe

THE Rev. P. Antonio Due Rojo, *S.J.*, has an article with the title, "En El Quarto Centenario Del Nacimiento de Tycho-Brahe" in *Euclides* of January 1946, No. 59, which briefly outlines the main features in the astronomical work of Tycho Brahe. As a practical astronomer, Tycho realized that the question of the true system of the world could be settled only by amassing evidence from the positions and motions of the planets. His long series of observations made possible the discovery of Kepler's laws of planetary motion and also the final proof of the heliocentric theory—a theory which Tycho himself had rejected The author refers to his relations with astrology, and mentions one of his books which was published after his death, with the expressive title, "Tychonis Brahe de disciplinis mathematicis oratio, in qua simul astrologia defenditur et ab objectionibus dissentientium vindicatur". A similar vindication of astrology was the subject of one of his conferences in the University of Copenhagen, and his position at the Court required an annual compilation of prognostications for the year following as well as horoscopes of each member of the royal family. It is interesting to know that the foundation stone of Uraniborg was laid on August 8, 1576, at a time when Jupiter and Regulus were in conjunction and the moon was in Aquarius, that is, when the celestial influences were most favourable. Whatever may have been the real views of some eminent astronomers on the subject, necessity sometimes compelled them to cast horoscopes as a means of livelihood. A well-known instance of this is seen in the case of Kepler, who cast horoscopes for princes and other important people. Probably astrologers in those days were able to ease their consciences by quoting the saying of the classical poet, "Mundus vult decipi: ergo decipiatur". In spite of his astrological practices, Tycho stands before the world as a renowned astronomer and an example of what can be accomplished by patient and persistent observation.

University Grants Committee

SIR Robert Greig and Sir Henry Tizard have resigned from the University Grants Committee. The Chancellor of the Exchequer has appointed the following new members : Miss D. Dymond, principal of Portsmouth Training College ; Mr. H. L. Elvin, principal of Ruskin College, Oxford ; Mr. H. S. Magnay, director of education, Liverpool ; and Prof. E. K. Rideal, director of the Davy Faraday Laboratory, Royal Institution. These appointments broaden the membership of the committee by going outside the strictly academic field of university education.

Commonwealth Travelling Fellowship for the Royal College of Surgeons

A PROMINENT New Zealand industrialist has made an anonymous gift to the Royal College of Surgeons of England for the endowment of a Commonwealth Travelling Professorship. The endowment will provide an income of about £2,000 a year, and the benefaction is to be known as a gift from "A New Zealand Family". A Commonwealth professor will be appointed each year and will generally be a prominent physician, surgeon or scientific worker resident in Great Britain or in Australia or New Zealand. The appointing authorities are also empowered, however, to elect as a professor a distinguished teacher from one of the other Dominions. The professor will be required to travel from the country where he or she is ordinarily resident to Great Britain, or to Australia and New Zealand, and to any other Dominion of the British Commonwealth, for the purpose of assisting in the advancement of medical science either by lecturing, teaching or engaging in research. It is hoped that the institution of this professorship will not only lead to the establishment of closer links between scientific workers in the Dominions and in the older seats of learning and centres of research, but also that the people of all nations will benefit. It is also hoped that it will be an important contribution to Imperial unity.

Scientific Approach to Foreign Affairs

In the latest and final "Looking Forward Pamphlet" (No. 9) of the Royal Institute of International Affairs, under the title "Foreign Affairs and the Public", Mr John Price deals with the connexion between foreign affairs and the daily interests of the individual citizen Explaining first the subject-matter of foreign affairs, he shows how the human element as well as questions of trade and security enter into it. Considerations of human conduct and morality complicate international affairs, and the greatest difficulties arise not from the problems themselves but from the policies of nations and governments determined to pursue their selfish ends by every possible means. The study of international affairs is not an exact science, nor concerned with the relations between nations in the abstract: it is a study of human affairs. That must be remembered in appraising the machinery for the conduct of foreign affairs, whether at the national or the international level. This machinery is well reviewed by Mr. Price in his next section, which gives a very clear picture of the limitation and purposes of world organisation. The new international organisations are being established in one sphere after another where the need for them is clearly felt, and machinery for collaboration at different levels and in all spheres must be provided if the tasks of maintaining security and promoting peace are to be accomplished

The purpose of security, however, is to provide the conditions in which civilization and culture can prosper, and Mr. Price then reviews both the methods and policies by which foreign affairs are conducted, and emphasizes finally the need for pursuing actively policies based upon international co-operation and world organisation. The fundamental difficulty the nations have to face is the reconciliation of national self-interest with the common good of the world as a whole. That is why public interest in foreign affairs is so important. We need experts, but we need also citizens who are able to see clearly, to judge shrewdly and to realize whether they are being given the essential facts We have to ensure that there are enough experts in the foreign service, and that they possess the requisite qualifications; but it is equally important that the ordinary citizen should have access to accurate, abundant and up-to-date information to enable him to understand more about the problems and difficulties, the needs and aspirations, the history and traditions of other countries and nations.

East African Industrial Research Board

The third annual report of the East African Industrial Research Board (P.O. Box 1587, Nairobi. 1*s*. 6*d*.) covers the year ended December 31, 1945, and includes, in addition to the chairman's report, those of the Tanganyika Industrial Committee and the Uganda Industrial Committee. Dr. A. J. V. Underwood continued to serve as overseas consultant, and the main preoccupation of the Board has been planning for the future of industrial research in East Africa. So far the governments concerned have not all accepted the proposals formulated by the chairman for an East African Department of Industrial Research and Development. The Board's research organisation continued on its war-time basis, but staff difficulties are expected to restrict its services in 1946. The technical publications of the Board appear to be meeting a public need, and a small technical library has been built up. While much of the time of the Chemical Laboratory has been occupied by analytical work, important work has been done on the development of phosphatic fertilizers, and a new product, 'Silicophosphate', is now undergoing extensive field trials Methods of mining salt from the salt lakes of Uganda have been under examination, and the improved quality of domestic pottery is largely due to the work of the Ceramics Branch. Attention was also given to the improvement of oil milling and soap manufacture, and draft specifications for soaps were prepared by the Panel on Oils and Fats and later adopted by the Government of Kenya.

The report of the Tanganyika Industrial Committee reviews the activities of the Hones factory, including slate pencil manufacture, which was closed on October 15, and of the Totaquina factory where a study of the quality and efficiency of extraction has established the relation between the total alkaloidal content of the bark and the quality and efficiency of extraction of the total alkaloids. The Uganda Industrial Committee is being disbanded this year, and the pottery, which did not enjoy a prosperous year, will then come under the direction of the Geological Survey.

Proceedings of the Academy of Sciences, Vienna

Volumes 148–151 inclusive, covering the years 1939–42, of Section II*a* of the *Proceedings* of the Academy of Sciences, Vienna, in which are published articles on astronomy, mathematics, meteorology, physics and technology, have recently been received. The number of articles contained in each volume is substantially the same, but this is considerably less than for volume 147, for 1938 A reduction in the page size of the pamphlet was made in 1940, and, in addition, in the following year, paper of an inferior and darker quality was introduced. The majority of the articles are theoretical. Of the experimental articles, those on the light properties of stars by K. Graff, and the "Communications from the Institute of Radium Research", of which several appear in each volume, are worthy of special mention. As is to be expected, the latter deal mainly with the properties of uranium and thorium, fission products and the effects of neutron bombardment. The purely mathematical papers include one on Laguerre's polynomials by A. Erdélyi, on the Euler–Maclaurin series and Bernouilli's numbers by A. Klingst, and on differential geometry by K. Strubecker.

Modern Views on Geography

In an inaugural address at the University of Liverpool entitled "The Theory and Practice of Geography" (University Press of Liverpool; London: Hodder and Stoughton, Ltd. 1*s*. net), Prof. H. C. Darby stressed the changes in ways of thought of the late eighteenth and early nineteenth centuries which had made place for the modern geographical outlook. He cited specially the widening of the scope of history, the rise of the social sciences and particularly the writings of F. Le Play, and the voyage of the *Beagle* with Darwin's stress on the importance of environment. Thus there was prepared the way for such geographical writers as A. von

Humboldt and K. Ritter In spite of the great progress made in geographical thought in recent decades, there is a noticeable lack, at least in English, of objective geographical studies of most parts of the world. British geography has progressed more on the study of topics than that of regions. Prof. Darby spoke of the importance of more regional study, especially with a historical bias, since the character of a region is based not merely on physical and economic facts, but also on the legacies of successive generations of its inhabitants.

Documentation in Switzerland

A SECOND, completely revised and augmented edition of "Führer durch die Schweizerische Dokumentation", by Theodore van Schelven (Amsterdam : Kosmos Publishing Co., Keizersgracht 133. 1 dollar), has now been published by the Swiss Association for Documentation. The pamphlet has proved of considerable value to Swiss research workers during the war years, since it quotes collections containing literature lacking in the large Swiss scientific libraries and which could not be included in the general catalogue of the Swiss National Library. The new edition lists 227 documentation centres arranged by subject according to the Universal Decimal Classification, together with alphabetical name, subject and place indexes, and a list of users of the Universal Decimal Classification. The introduction includes brief notes on the Swiss Association for Documentation, the Swiss Association of Librarians, the general catalogue and information service of the Swiss National Library, Berne, on documentation terminology, the standardization of documentary aids and a bibliography of publications of Swiss authors on documentation, bibliography and the decimal classification.

Silicon Carbide Non-ohmic Resistors

DURING the past decade, resistors having silicon carbide as basic ingredient and characterized by a striking departure from Ohm's law—the current passed being proportional to the fourth or fifth power of the applied voltage—have become available commercially and are now widely used in many fields of electrical engineering Their development was first stimulated by the requirements of surge diverters (lightning arresters) for overhead power transmission lines, but success in this application had led to their use for the protection, at much lower voltages, of the highly inductive coils found in electrical machinery, contactors, clutches, brakes, relays, etc. An important advantage arising from the limitation of the peak voltage developed when such coils are disconnected from the supply is the reduction of the sparking at opening contacts, and of the radio interference to which such sparking gives rise. This method of spark quenching has received particular attention in connexion with telephone relays, where the preservation of contacts is of great importance. Silicon carbide resistors have also found application for the protection of radio transmitting and receiving circuits and of electrical instruments, and for scale modification in the latter ; in metadyne systems, where they permit practically any desired main motor characteristic to be obtained ; and in non-linear bridge circuits. The characteristics and limitations of these resistors, and the principles governing their application, are discussed in a recent paper by Messrs. F. Ashworth, W. Needham and R. W. Sillars (*J. Inst. Elect. Eng.*, 93, Part 1, No. 69 ; Sept. 1946), with which is associated an extensive discussion.

Research on Multiple Sclerosis

THE Association for Advancement of Research on Multiple Sclerosis, the address of which is New York Academy of Medicine Building, Fifth Avenue and 103rd Street, New York 29, N.Y , has been formed by a group of multiple sclerosis patients, with their many friends and relatives, in co-operation with some of the leading neurologists of North America. Its aims are : (1) co-ordination of research efforts on multiple sclerosis ; (2) collection of statistics on its prevalence and geographical distribution ; (3) to act as a clearing house for information on this disease ; (4) education of the public on the problem of multiple sclerosis ; (5) collection of funds to stimulate and support research on multiple sclerosis and allied diseases. For the present, the Association proposes to conduct a membership drive for the enrolment of multiple sclerosis patients as well as the public, in an endeavour to obtain more definite statistical data on the prevalence of the disease Dr. Tracy Jackson Putnam, director of Services of Neurology and Neurological Surgery, Neurological Institute of New York, is the honorary chairman of the Association.

Institution of Civil Engineers

SIR WILLIAM HALCROW, in his presidential address to the Institution of Civil Engineers on November 5, reviewed the accomplishments of the Institution, more particularly during the past fifteen of the 128 years that it has been in existence. Not every engineer will agree with Sir William's opinion that too much reliance should not be placed on theoretical knowledge. Engineering is an applied science, and therefore the provision of facilities for practical training, as distinct from practical experience, cannot receive too much attention from the Institution ; but it is impossible for the engineer to have too much knowledge of the fundamentals or theoretical basis of his science. The civil engineer's record during the War when, as Sir William points out, 'Mulberry' and 'Pluto' were designed, would have been even more spectacular if fundamental knowledge, essential in dealing with new and complex problems, had been more widespread.

Another matter of considerable moment, dealt with by Sir William in his address, was the difficulty met with to-day in presenting the views of the profession as a whole on matters of public interest, due to the large number of engineering institutions which exist. While the Institution's present policy of setting up sectional divisions specializing in the various branches of professional work may make unnecessary the creation of more institutions, it is unlikely to do much to encourage the existing smaller institutions to amalgamate. The value of amalgamation which would enable engineers, who should form a most influential section of the community, to speak with one voice, is recognized by all but a very small minority. That small minority, however, inevitably includes the most influential and hard-working members of the smaller institutions, who are naturally governed by a sense of loyalty to their own organisations. It will need a measure of self-sacrifice and a sense of wider loyalty to the profession as a whole to right the position.

Officers for 1946–47

THE following have been elected officers for 1946–47 of the Institution of Civil Engineers: *President*, Sir William Halcrow ; *Vice-Presidents*, Sir Frederick

Cook, Sir Reginald Stradling, Sir Jonathan Davidson, Sir Roger Hetherington ; *Other Members of Council*, Mr. H. E. Aldington, Sir Stanley Angwin, Mr. D. B. Brow (India), Mr. W. S Cameron, Mr. F. M. Corkill (New Zealand), Dr W. H. Glanville, Mr. A. Gray (Canada), Mr. G. L. Groves, Mr. H Hamer, Dr. E J. Hamlin (South Africa), Mr. A. C. Hartley, Mr. G. H. Humphreys, Mr. L. Leighton, Mr. M. G. J. McHaffie, Mr. M. S. Moore (Australia), Mr. W. H. Morgan, Dr. H. J. Nichols (India), Mr. C. M. Norrie, Sir Leonard Pearce, Prof. A. J. S. Pippard, Mr. V. A. M. Robertson, Mr. W. P. Shepherd-Barron, Mr. W. K. Wallace, Mr. D. M. Watson, Sir Arthur Whitaker ; *Past-Presidents*, Sir John Thornycroft, Dr. David Anderson, Mr. F. E. Wentworth-Sheilds, Sir Peirson Frank ; *Secretary*, Mr. E. Graham Clark

Curare in Anæsthesia

THE Anæsthetics Committee, jointly appointed by the Medical Research Council and the Royal Society of Medicine, is considering the standardization of curare. There are on the market at present two preparations for use in anæsthesia, one amorphous and one crystalline, but both depend for their activity on *d*-tubocurarine chloride, the co-existence of preparations of different potency is a source of danger and may result in serious accidents. The amorphous preparation, "Intocostrin", has, in fact, about one-quarter the activity of the pure crystalline material. There is also some evidence of wide differences in the reactions of the patient, depending to some extent on the state of health of the individual at the time. The Committee, therefore, considers it advisable, in the present state of knowledge, to base the dose on the individual reaction to an initial small injection rather than on any dose/weight ratio. In the average healthy adult this initial dose could be 10–15 mgm. of crystalline *d*-tubocurarine chloride or 40–60 mgm. of "Intocostrin". In one otherwise healthy man with a recent perforated gastric ulcer, so little as 5 mgm of the crystalline material produced adequate muscular relaxation, and 15 mgm. would probably have been a considerable overdose

The Anæsthetics Committee has been reconstituted with the following membership : Dr. C. F. Hadfield (chairman), Prof. F. H. Bentley, Dr. C. Langton Hewer, Mr. R. Vaughan Hudson, Dr. H. King, Prof. R. R. Macintosh, Dr. F. C. MacIntosh, Dr. M. D. Nosworthy and Dr. G. S. W. Organe (secretary).

Museums and the Development of Visual Education

A BRIEF report of a paper entitled "Museums and General Education", read by Mrs. Jacquetta Hawkes (Ministry of Education) on the occasion of the Museums Association Conference last July, appears in the *Museums Journal* of October 1946, p. 118. Mrs. Hawkes said that at the present time there is in the educational world a great vogue for the use of visual teaching methods. Unfortunately, visual education often means films mainly intended for factual instruction. Museums are uniquely qualified for visual education, because they can offer real things that can be handled. Mrs. Hawkes went on to suggest that museums should design exhibits to give intellectual instruction, offering objects without comment. By this encouragement of the intuitive sense and training in the judgment of individual quality, Mrs. Hawkes believes that museums can make their most valuable and distinctive contribution to the content of education. If her words reflect the attitude of the Ministry of Education, they form a happy augury for the improvement of the museum services of Britain, and it is highly important that this interest should be further explored by leading museum authorities.

Jubilee of the Discovery of the Electron

THE fiftieth anniversary of the discovery of the electron by Sir J. J. Thomson will occur next year. To mark this jubilee and to demonstrate the tremendous influence such an advance in pure physics may have on the life of the community, the Physical Society and the Institute of Physics are jointly arranging a series of meetings and other functions to take place during September 25 and 26, 1947, in London. A special exhibition, which will remain open to the public for several weeks, will be held at the Science Museum, South Kensington, and will show the development of a vast range of modern industrial equipment from its earliest experimental origins.

Announcements

THE eleventh Liversidge Lecture of the Chemical Society will be delivered by Prof. Harold C. Urey, of the Institute of Nuclear Studies, University of Chicago, at the Royal Institution, London, W.1, on December 18 at 7.30 p.m. He will speak on "Some Problems in the Separation of Isotopes".

SIR ALEXANDER FLEMING has been awarded the honorary gold medal of the Royal College of Surgeons in appreciation of his distinguished work and particularly in recognition of his discovery of penicillin.

MR. KENNETH CARTER has been appointed secretary of the Therapeutic Research Corporation of Great Britain, Ltd., in succession to Dr. Frank Hartley.

THE Cambridge Philosophical Society announces that the adjudicators for the Hopkins Prize have made the following awards for the period 1933–39 : to Prof. J. D. Cockcroft, director of the Atomic Energy Research and Development Establishment at Harwell, for researches on the artificial transmutation of elements ; and to Prof. E. A. Milne, Rouse Ball professor of mathematics in the University of Oxford, for researches on stellar structure and cosmology.

PROF. H. HARTRIDGE, professor of physiology at St. Bartholomew's Hospital Medical College, University of London, will deliver the Christmas Lectures "adapted to a Juvenile Auditory" at the Royal Institution on December 28, 31, January 2, 4, 7 and 9 ; he will speak on "Colours and How We See Them".

MR. N. J. SCORGIE, reader in the Department of Animal Husbandry at the Royal Veterinary College, has been appointed to the Courtauld chair of animal husbandry, veterinary hygiene and dietetics in the College in succession to Prof. W. C. Miller, who resigned the chair in order to take up an appointment as director of the Equine Research Station of the Veterinary Educational Trust.

DR. W. L. WATERHOUSE, reader in the Faculty of Agriculture of the University of Sydney, has been appointed research professor in agriculture in recognition of his work in cereal pathology.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

An Antibacterial Substance from *Arctium minus* and *Onopordon tauricum*

EXTRACTS of *Arctium minus* Bernh. (a plant which was erroneously listed in a previous publication[1] as *Arctium lappa* L) were found by Osborn[1] to contain an antibacterial principle. In May 1945 the substance responsible for the antibacterial action of the extracts was isolated from the radical leaves of *Arctium minus* Bernh. in a crystalline form. More recently, the same substance has been isolated from first-year plants of *Onopordon tauricum* Willd , a southern European species belonging to the same section of Compositæ as *Arctium*.

The substance was isolated from *Arctium minus* Bernh. in the following manner. An aqueous extract was made by grinding the fresh leaves of the plant with sand, in the presence of water, and pressing the fluid through silk. The extract was adjusted to *p*H 3, boiled and centrifuged. The supernatant liquid was extracted three times with an equal volume of ether, and the combined ethereal solutions passed through a column of acid-washed (*p*H 5) Brockmann alumina. The active substance passed through the column and was collected in the percolate. From the most active fractions of the percolate, crystals of the antibacterial substance were deposited on standing in the ice-chest; further crystalline material was obtained from the less active fractions by concentrating these *in vacuo*. The substance was recrystallized by the addition of ether to a concentrated solution of it in warm ethyl acetate.

A crystalline substance with antibacterial properties was isolated from *Onopordon tauricum* by a procedure similar to that used for extracting the active principle from *Arctium minus* Bernh. X-ray powder photographs showed that the two substances were identical.

When tested by the cylinder-plate method[2] on a plate seeded with a 24-hour culture of staphylococci diluted 1 : 1,000, a solution containing 0·5 mgm. per ml. of the crystalline substance in 10 per cent aqueous ethanol gave a zone of inhibition of about 20 mm. diameter. A solution containing 2 mgm. per ml. of the substance produced no inhibition on a plate seeded with *Bact. coli*.

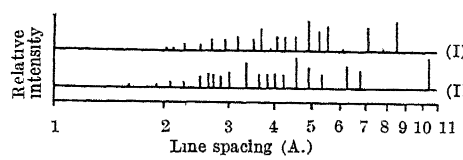
The active substance is neutral and crystallizes in small orthorhombic plates, m.p. 57–59°. It is optically active, $[\alpha]_D^{20}$ in ethanol being $+ 161°$ and $[\alpha]_D^{20}$ in acetone $+ 157°$. It is readily soluble in ethanol, acetone, ethyl acetate, or chloroform, sparingly soluble in water or ether and insoluble in petroleum ether.

The results of elementary analysis of the substance (C, 64·2; H, 7·1) indicated that it had the empirical formula C_3H_4O. X-ray crystallographic measurements gave the following unit cell dimensions: $a = 12{\cdot}3$ A.; $b = 7{\cdot}0$ A.; $c = 20\ 5$ A. The space group was found to be $P2_12_12_1$; and the number of molecules in the unit cell (n) was 4. Values obtained for the density of the crystals averaged 1·27. The molecular weight, calculated from these figures was 339 ± 12, or a submultiple of this. The equivalent weight of the substance, determined by alkaline titration, was 325. From these data it appeared that the molecular formula for the substance was $C_{18}H_{24}O_6$ (mol. wt. = 336)

The substance contained one C-methyl group, but no methoxyl. Hydrogenation in the presence of palladium–charcoal catalyst resulted in the uptake of eight atoms of hydrogen per mole and loss of antibacterial activity. In chloroform–carbon tetrachloride solution the substance absorbed eight atoms of bromine per mole. A solution of the substance in 10 per cent aqueous ethanol gave no coloration with ferric chloride and only a faint opalescence on addition of Brady's reagent.

The active substance was stable to dilute acid but was inactivated by dilute alkali. On shaking with 0 1 *N* baryta, it dissolved slowly with the liberation of one acid group. A second acid group was liberated gradually when the alkaline solution was allowed to stand at room temperature, and more rapidly on heating at 100°. Back titration of the solution immediately after the substance had dissolved, using phenolphthalein as an indicator, indicated an apparent equivalent weight of 325; after heating in alkaline solution for 45 minutes at 100°, the back titration value corresponded to an equivalent weight of 170.

These properties are compatible with a structure containing four double-bonds of aliphatic character, an ester group and a lactone ring The substance did not give the Legal nitroprusside reaction for βγ-unsaturated lactones having an α-hydrogen atom[3], however, nor, like certain αβ-unsaturated lactones, did it reduce, at room temperature, ammoniacal silver nitrate containing caustic soda.



POWDER PHOTOGRAPH LINES OF (I) AND (II)

On keeping in air the antibiotic underwent a change, and after several weeks the substance did not melt at 200°, was pseudocrystalline and was insoluble in solvents such as ethyl acetate. The figures obtained on elementary analysis indicated that this change was the result of an oxidation. When stored under petroleum ether, the antibiotic could be kept unchanged for a considerable time.

Cavallito, Bailey and Kirchner have also isolated an antibacterial substance from samples of *Arctium minus*[5]. Their substance (I) had the same empirical formula (C_3H_4O) as the product (II) described here. The two substances appeared to have similar solubilities, and both were sensitive to alkali and oxidized by atmospheric oxygen; but large differences between the values for the melting point and optical activity of (II) and those reported for (I) indicated that they were not identical. The non-identity of the crystals was confirmed by a comparison of X-ray crystal photographs of (II) with those of a sample of (I) kindly sent to Dr. Heatley by Dr. Cavallito. The accompanying diagram shows the relative intensity of the powder photograph lines of (I) and (II) plotted against the spacing of the lines in angström units. The two substances had a very similar activity against *Staph. aureus* when tested by the cylinder-plate method.

On the basis of titration values for the acid liberated on treatment of the substance with alkali, and of analytical data for an isopropylamine derivative, Cavallito *et al.* assigned to their product the molecular formula $C_{15}H_{20}O_5$. X-ray crystallographic analysis of the sample of (I) in our possession, which was in the form of orthorhombic needles, gave the following results: $a = 12{\cdot}3$ A.; $b = 11{\cdot}0$ A.; $c = 13{\cdot}8$ A.; space group $P2_12_12$; $n = 4$; density 1·19; molecular weight 337 ± 12 (or a submultiple of this). This molecular weight corresponded to a molecular formula $C_{18}H_{24}O_6$, and suggested that (I) and (II) might be isomeric.

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Factors Contributing to the Bacteriolytic Effect of Species of Myxococci upon Viable Eubacteria

ALTHOUGH the lytic effect of certain myxobacteria upon the true bacteria (eubacteria) has been known for some years[1-4], the mechanism of the process is imperfectly understood, and no one seems hitherto to have studied the possible production of antibiotic substances by the first-named group of micro-organisms. One of us (B. N. S.) has recently shown[5] that some species of the Myxococcaceæ undoubtedly cause lysis of living as well as dead bacteria, particularly upon solid non-nutrient media, but attempts to grow the lytic strains in suspensions of eubacteria in very dilute salt solution succeeded only when the latter were mostly non-viable. A possible explanation of this apparent anomaly is that the growth of the myxococcus concerned, upon dead bacteria or their products of disintegration, results in the production of a true non-enzymic antibiotic substance capable of killing viable eubacteria and so rendering them susceptible to lysis by the exocellular enzymes previously elaborated by the growing myxococci. If, therefore, an inoculum of myxococcal microcysts is made into a suspension of chiefly viable bacteria in a liquid, the minute amount of growth which can take place quickly upon the few dead bacteria will be insufficient to produce a high enough uniform concentration of antibiotic substance to kill any viable bacteria, and so growth ceases; but if an inoculation is made upon a dense mass of eubacteria on a solid medium, diffusion of metabolites is hindered and a high enough concentration of antibacterial substance is built up in the vicinity of the inoculum to kill some of the viable cells in that region and so enable growth of the myxobacterium to continue with progressive lysis of the eubacterial mass. We present below some evidence concerning the separation of the soluble non-enzymic antibiotic substance from the accompanying exocellular lytic enzymes which are active against non-viable bacteria only.

In one instance, namely, a strain of *M. virescens* derived from soil, the separation has been achieved by the simple expedient of growing the organism in a cell-free liquid medium of simple composition and isolating a crude non-enzymic antibiotic substance, soluble in certain organic solvents, from the metabolic liquid by chemical means. This medium contained the amino-acids of a total acid hydrolysate of casein (*c.* 1 per cent) as sole source of carbon and nitrogen, and the optimum period of incubation for production of antibiotic substance was about ten days at 24° C. Incubation for a further fourteen days resulted in the total disappearance of antibacterial activity against *Staphylococcus aureus* for example, but the metabolic liquid still had good proteolytic activity against gelatin or the proteins of nutrient broth, and also bacteriolytic powers against dead bacteria, particularly of Gram-negative species. It had no action at all against suspensions of viable eubacteria made from a young nutrient agar slope. On the other hand, the crude antibiotic substance, which appeared to be associated with the valine-leucine fraction of the monamino-mono-carboxylic acids of the casein hydrolysate, had no proteolytic or bacteriolytic powers whatever. The most active preparation so far obtained completely inhibited the growth of *Staphylococcus aureus* at a concentration of 0·008 per cent in heart broth, but as this alcohol-soluble material consisted chiefly of valine and the leucines, the real antibiotic substance is probably of much greater activity than this.

It is a curious fact that the antibiotic substance acts much less powerfully upon Gram-negative than upon Gram-positive viable bacteria, while the reverse is true for the action of the lytic (proteolytic) enzymes upon dead bacteria. Hence it is not surprising that myxococci seem often to grow almost equally well on either kind of eubacteria, when presented as a partly living substrate upon solid media.

Our results will be reported in more detail elsewhere, but it is worth emphasizing a fact not generally known, namely, that myxococci can often be grown without difficulty in simple cell-free liquid media containing nothing more complex than amino-acids, and hence are amenable to the usual procedures employed for the study of the metabolism of moulds, yeasts and eubacteria, including the production of antibiotic substances.

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Pterygospermin: the Antibacterial Principle of *Moringa pterygosperma*, Gaertn.

THE discovery and use of penicillin and streptomycin has led to a search for similar antibiotics in other fungi and in higher plants. Systematic studies conducted in these laboratories[1] have shown the possibilities of a number of plant materials, reported in Indian medicine, which contain antibiotic substances effective against both Gram-positive and

Gram-negative organisms. In a recent publication[2] a plant antibiotic effective against even acid-fast organisms has been described. The present communication deals with the antibacterial properties of the extracts of the root of *Moringa pterygosperma*.

It was found that alcoholic extracts of different parts of *M. pterygosperma* showed pronounced antibiotic activity. The maximum activity was found to be in the roots. Apart from the work on the alkaloids[3,4], there is practically no information regarding the other principles present in the root of this plant. The separation of the antibacterial substance present in the root, which has been provisionally named 'pterygospermin', was therefore undertaken.

We adopted the following procedure. The root was cut into small pieces and extracted overnight in the cold with absolute alcohol. The alcoholic extract was then shaken well with active carbon, when 'pterygospermin' was completely adsorbed on the carbon. Elution with petroleum ether and subsequent removal of the latter in vacuum furnished an oil having a highly irritating smell. The oil is soluble in alcohol, and is the most active product yet obtained. The antibiotic is only slightly soluble in water, but forms an emulsion at high concentrations.

The accompanying table gives the antibacterial spectra of the substance isolated.

Organism	Dilution of antibiotic in media 1/20,000	1/30,000	1/40,000	1/50,000	1/75,000	1/100,000
1. *B. subtilis*	−	−	−	−	−	+
2. *S. aureus*	−	−	−	−	−	+
3. *B. dysenteriæ* Flexner	−	−	−	+	+	+
4 *B. aerogenes*	+	+	+	+	+	+
5. *B. paratyphosus* B	−	−	−	+	+	+
6. *B. paratyphosus* C	−	−	+	+	+	+
7. *B. typhosus*	−	−	−	+	+	+
8. *B. coli*	+	+	+	+	+	+
9. *B. enteritidis*	−	−	+	+	+	+

− indicates no growth ; + indicates growth.

Pterygospermin exhibits pronounced antibacterial activity against both Gram-positive and Gram-negative organisms, the former being inhibited at a dilution of 1 in 75,000 and the latter at 1 in 40,000. Preliminary experiments with an acid-fast organism *Mycobacterium phlei* show that the antibiotic inhibits the growth of this organism at a dilution of about 1 in 30,000. Further work regarding its activity against *M. tuberculosis*, and pathogenic fungi, its toxicity, use as a chemotherapeutic agent, as well as its properties as an antibiotic are in progress.

Our thanks are due to Prof. V. Subrahmanyan, Drs. N. N. De and K. P. Menon for their interest and valuable suggestions. We gratefully acknowledge generous support from the Council of Scientific and Industrial Research, under the auspices of which this work is being carried out.

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Transfer of Phosphate by Coenzyme I

IN 1938, Ostern *et al.*[1] put forward a hypothesis according to which the function of coenzyme I is to transfer phosphate. It was suggested that the coenzyme in muscle, while taking up two hydrogen atoms in the pyridine nucleus through the addition of free phosphate, undergoes a phosphorolysis and is split into pyridin nucleotide and adenosine diphosphoric or triphosphoric acid. After the splitting off of phosphate, the adenine part of the coenzyme molecule recombines with the pyridine nucleotide part. In yeast, however, this mechanism was assumed to function in a somewhat different way, on account of the ability of the yeast enzyme to phosphorylate adenosine. Here also the hydrogenation would be accompanied by a hydrolysis of the coenzyme molecule followed by a transfer of the phosphate of the adenylic acid to other phosphate acceptors. In the regeneration of the coenzyme molecule occurring through the dehydrogenation of the pyridine nucleus, inorganic phosphate is said to be taken up. The validity of this hypothesis was tested in experiments *in vitro* by Meyerhof *et al.*[2]. With the aid of radioactive phosphate they showed that the coenzyme I did not incorporate phosphate either at the hydrogen transfer or at the phosphate transfer.

We have carried out similar experiments with a complete apozymase fermentation system containing radioactive orthophosphate. The coenzyme recovered after the evolution of a considerable amount of carbon dioxide did not show any radioactivity. Experiments *in vivo* with baker's yeast demonstrated, however, that radioactive phosphate introduced into the cells was incorporated into the coenzyme molecule (329 mgm. coenzyme isolated from 6 kgm. yeast treated in 5·5 litres of liquid for one hour with 0·1 milli-Curie showed an activity corresponding to $22 \cdot 9 \times 10^{-6}$ milli-Curie). The rate of this process was under certain conditions dependent on the rate of metabolism ; but the phosphate exchange also took place in the absence of exogenous substrate at low temperature (+4° C.), though at a very slow rate. From this we conclude that the function of coenzyme I is to transfer phosphate, and that the systems *in vitro* used by Meyerhof *et al.* and by us do not reproduce the conditions in the living cells.

The analysis of the results is being continued, and a full account will shortly appear elsewhere.

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Low-Voltage Discharge of the Electric Eel

THE Amazon eel (*Electrophorus*) presents two types of discharges : one occurring in groups of high voltage, and another one, which appears in single peaks, of very low voltage[1,2].

We have made some oscillographic studies of this discharge, attributed by various authors to the bundle of Sacks. We have used an Allen B. Dumont

Fig 1

Fig 2

SWEEP-TIME, 1 MSEC.

cathode ray oscillograph, Type 175 A., using either the anterior or the posterior discharge to start the sweep of the cathode beam.

Fig. 1 shows a picture of the oscillograph screen when the anterior part provided the positive pulse necessary to discharge the sweep circuit. It is seen that there is a peak which has the polarity corresponding to the discharge of the posterior part, which was connected to the vertical plates.

This figure shows that the discharge occurs an instant before the pulse which initiated the sweep of the cathode beam. The results are confirmed by Fig. 2, in which the connexions were reversed. The anterior part was connected to the vertical plates and the posterior part to the circuit which discharges the sweep. (The connexion was made through an electronic tube so as to produce a necessary inversion of polarity. As is known, the sign of the electric pulse at this point is negative[3].) It is apparent that the potential applied to the vertical plates presents a time-lag in relation to the one which initiates the sweep.

The experiments suggest that the small peaks begin at the posterior part of the organs. Very rough measurements indicated a pulse speed of approximately 1,600 metres a second.

It should be pointed out that we used a fish in which two small windows had been cut through the skin a week before, thus ensuring the insertion of the electrodes directly in the principal organ anteriorly, and in the bundle of Sacks posteriorly.

Further details will be published later.

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Skim Cheese as an Indispensable Food for the Poor in Egypt

SKIM cheese is prepared in Egypt from milk skimmed by hand. It may either be eaten fresh or left to ripen in baked earthenware pots. To it may be added whey, skim or whole milk, etc. Even under careful supervision, preparations made by the same process showed wide variation in composition.

Values are presented for the protein content of skim cheese from various localities. The amount varies from 6·69 to 21·94 per cent and averages 16 63 per cent. This rather wide variation demonstrates the influence of the methods employed in preparing and processing this foodstuff on its protein value. Our values agree favourably with the amount of protein present in cottage cheese (soft unripened cheese resembling our skim cheese) where it varies from 12·70 to 21·00 per cent according to Right. This finding supports the idea that most varieties of skim cheese examined must find their most useful place as protein supplements in human diet.

The most variable constituents are fat and water. Fat was found to be practically absent in some samples but high in others, reaching 19·51 gm. per cent. The high figures are found only in the stored cheese due to the materials added (for example, whole milk). The average amount of fat is 4·16 per cent. It is thus richer than cottage cheese where the fat content does not exceed 1·90 per cent. The variation in the water content is quite conspicuous. It ranges from 52·30 to 84·85 per cent, and so differs from cottage cheese where the range is between 71·40 and 79·90 per cent.

The calcium content varies from 0·130 to 0·817 gm. per cent with an average of 0·292 gm. per cent. This shows that skim cheese is an excellent source of calcium in the diet especially if compared with the amount of calcium present in milk, eggs, wheat or white bread. Phosphorus varies from 0·110 to 0·573 gm. per cent with an average of 0·282 gm. per cent. Skim cheese is also a good source of phosphorus compared with milk, eggs, wheat or white bread. The diet of the poor in Egypt contains a lot of green vegetables such as watercress, radishes, chicory, etc., which are also very rich in phosphorus.

As regards vitamins, skim cheese contains an amount of vitamin B_1 too small to be considered. Nicotinic acid presents itself in the range of 0·19–1·89 mgm. per cent with an average of 0·70 mgm. per cent. The amount of vitamin A averages 17 I.U. per 100 gm., although it may reach 1,463 units in some samples rich in fat.

The digestibility of proteins, fats, calcium and phosphorus of skim cheese was found to be 96, 87, 67 and 74 per cent compared with that of the ordinary soft non-skim cheese which is 96, 97, 60 and 89 per cent respectively. The amount utilized of these ingredients in skim cheese is shown to be 27, 38, 41 and 8 per cent compared with that in non-skim type, which is 53, 89, 43 and 46 per cent respectively. Thus increase of fat content improves the utilization of protein, fat and phosphorus, but has no effect on calcium utilization.

Skim cheese is the cheapest kind of cheese; it is possible to buy for five millimes more than a pound of skim cheese containing 90 gm. of casein or even more.

Skim cheese can thus be regarded as an almost indispensable protective food for the poor in Egypt. Although it lacks some of the vitamins through partial removal of fat, it still retains the most highly nutritive protein (casein), a part of the vitamins, most of the calcium and phosphorus. It is, in fact, an excellent source of phosphorus and particularly of calcium. It has been observed in Egypt that in districts where skim cheese is frequently eaten no rickets occur.

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Oct. 2.

Use of Growth-promoting Substances for Weed Control in Sports Turf

IN a recent article, Templeman[1] discusses the use of growth-promoting substances for selective weed control, referring particularly to agricultural operations with 2-methyl-4-chloro-phenoxyacetic acid ('Methoxone' or M.C.P.A.). He is concerned mainly with annual weeds, while the problems associated with control of well-established perennial weeds in a turf sward call for a somewhat different approach.

Starting only last autumn, we have carried out an extensive experimental programme to try out the most promising of the growth-promoting substances, namely, 'Methoxone' and '2 : 4.D' (2 : 4-dichlorophenoxyacetic acid, D.C.P.A.), on closely mown swards containing the commoner turf weeds. Experiments conducted by us have followed a replicated random block technique. New experiments have been commenced at frequent intervals throughout the year, and different rates and methods of application have been tried. In addition, the effects of mowing and of different fertilizer treatments have been studied in conjunction with the two substances. A considerable number of simple large-scale co-operative trials conducted throughout Britain are providing ample confirmation of our experimental findings as regards 'Methoxone', but adequate supplies of '2 : 4.D' were not available in time for similar large-scale trials to be carried out with it this year. We hope to pursue this object next season.

Results have been most gratifying. Under suitable conditions of weather and growth, 'Methoxone' applied at the rate of 6 lb. per acre, as spray or powder, will give practically complete control of the more common weeds of turf including broad-leaved plantain (*Plantago major*), ribwort plantain (*P. lanceolata*), buck's-horn plantain or starweed (*P. coronopus*), self-heal (*Prunella vulgaris*), creeping buttercup (*Ranunculus repens*) and cat's-ear (*Hypochœris radicata*). We have found control to be speedier and more efficient if application of 'Methoxone' is preceded by a dressing of nitrogenous fertilizer, such as sulphate of ammonia. This seems to increase the effect of 'Methoxone' on the weeds and at the same time masks the slight check caused to the growth of the sward. It also encourages the grass to 'fill in' after the weeds. Results with '2 : 4.D' are not dissimilar from those obtained with 'Methoxone', although it seems possible that rather lower rates per acre may prove adequate.

Typical results are shown in the accompanying table, which summarizes some of the results obtained in an experiment carried out on a local cricket ground in July. Effective control was measured six weeks after treatment, all plots in this case having

Treatment	Percentage area covered by 'main weeds'		Per cent control
	Before treatment	After treatment	
Control	25 8	26 2	—
6 lb 'Methoxone' per acre as spray	25 8	2 6	89 9
6 lb 'Methoxone' per acre as powder	33 5	5 6	83 3
6 lb '2 . 4.D' per acre as spray	43 0	3 4	92 1
6 lb '2 . 4 D' per acre as powder	35 2	0 7	98 0

received pre-treatment with nitro-chalk seven days in advance of the weed-killer application. The 'main weeds' were daisy (*Bellis perennis*), dandelion (*Taraxacum* sp.), clover (*Trifolium repens*), plantain (broad-leaved and rib-wort) and self-heal.

Heavy rain falling shortly after application of either chemical is likely to nullify its effects. The experiments show some differences between the effects of 'Methoxone' and '2 : 4 D', such as, for example, in persistency and in effects on germination and growth of grass seeds.

A fuller account of this work will be published in the next issue of the *Journal of the Board of Greenkeeping Research* and elsewhere; to those responsible for the management of turf the introduction of 'Methoxone' and '2 : 4.D' would appear to open up an entirely new approach to the turf weed problem.

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[1] *Agriculture*, 53, No. 3, 105 (1946).

Methods of Marking Reptiles for Identification after Recapture

WHEN studying, in the summer of 1939, a mid-Swedish population of the grass-snake, *Natrix n. natrix* (L.), we considered it necessary to work out some method of identifying each individual snake from year to year, making it possible to follow its changes in colour and size, etc., with increasing age, the appearance and subsidence of sicknesses, the healing of wounds, the sexual cycle, and movements within the territory inhabited by the population The movements of individuals could not be studied in any other way; and the morphological changes with age were otherwise determinable merely as a result of statistical population studies, which could only be rough approximations, the individual variation in growth being far too great for it to be possible to distinguish the higher age-classes even with plentiful material.

Three methods, with some variations, were tried concurrently. Scissor cuts removing part of a subcaudal shield were made in various combinations, permitting of the distinctive marking of a great number of individuals. This method was used some years ago by Blanchard and Finster[1] with some American snakes, among which was also one of the genus *Natrix* (*N. sipedon*). However, such marks do not seem to be quite permanent, the growth of the shield leaving after some years but slight trace of the incision. Thus it is necessary to recapture the snake within a limited space of time and to mark it again if it is to be possible to follow it during a considerable period Furthermore, the subcaudals of the new-born young are difficult to deal with, at least in the case of small species, as well as the ventrals (with which corresponding trials were made in our specimens). Their frequent skin changes also eliminate the scars rather soon. Being specially interested in young individuals, we decided not to proceed with this method.

The impossibility of marking new-born specimens is also a great obstacle to the use of numbered metal objects. Even with older individuals it is difficult to find any type of marking which is not obliterated by wear or by skin change and growth. At least for the small European species, this method is not practicable.

The third method had an initial advantage compared with the others, as it called for no incision in the snake. It was based on the fact that the black-and-white pattern which is found on the under-side of the grass-snakes has an infinite range of variation. Assuming that this pattern remains constant during the life of the specimen, we took photographs of a series of snakes showing a sequence of ventral shields of different patterns, after which the snakes were released. The result was quite satisfactory. On the recaptured specimens there was complete conformity with the earlier photographs as regards the distribution of black and white, the smallest details being still unchanged after a considerable increase in size—a system as sure as the finger-prints of the police. This method was a help to us in the study of many problems in the biology of *Natrix*, as we could follow the individual snake from its early days to its death, noting at varying intervals interesting changes in detail. At present, we have populations 'marked' in various parts of Sweden. A sequence of four to eight of the first twenty ventrals has been drawn for every specimen in our register, and the identification is furthermore confirmed by details noted for taxonomic purposes, such as the number of ventrals and subcaudals, variations in the scales of head and throat, and the type of design on the upper side.

The application of the method to other species than *Natrix natrix* has not yet met with any insurmountable difficulties For many members of the same genus the ventrals have patterns similar to those of the grass-snake. As regards other groups, photographs of the back pattern can be used for *Coronella* and *Vipera* species, as we have found in populations studied by us; and most other snakes are likely to have some constant pattern which can be employed for the same purpose.

A point of interest was the discovery that good results could be obtained in just the same way with lizards; we have worked with *Lacerta vivipara* (photographs of back pattern) and *Anguis fragilis* (photographs of throat).

Recent experiments made by Edelstam with this method on amphibians have already given positive results. Possibly the characteristic dark-and-light patterns occurring in many groups of Anura and Urodela will prove as serviceable in this respect as that of the reptiles.

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Oct. 20.

[1] *Ecology*, 14 (1933).

Occlusion of the Oviduct in the Cloaca after Spawning in some Salientia

IT has been stated that the Mullerian ducts of frogs and toads open into the cloaca comparatively late in life, generally when the female becomes sexually mature[1,6]. It is not recorded whether they remain open or close up after spawning[1-6]. In the course of investigations on the urinogenital organs of Salientia, I have observed an occlusion of the oviducal (uterine) aperture in the cloaca which deserves notice.

A 38·0-mm. breeding female marsupial frog, *Gastrotheca boliviana griswoldi* Shreve, carrying eight developing eggs in its dorsal integumentary pouch, was dissected and found to possess enlarged oviducts and spent ovaries. In their course from the posterior level of the kidneys the oviducts are dilated into uteri which run in apposition to each other so closely that only a partition wall separates the two. The Wolffian ducts run dorsally and are closely apposed on the outer walls of the uteri. The posterior region of the gut and the urinogenital ducts were carefully dissected out. and serial transverse sections at 10 μ were made. The sections show that the inner uterine wall has longitudinal folds with a glandular epithelial lining, and that the two uteri become confluent posteriorly through the disappearance of the partition wall. Thus a common uterus is formed which runs for about a millimetre (90 sections) before terminating in the cloacal wall. As the common uterus and the overlying Wolffian ducts are incorporated within the cloacal wall, there is formed a urinogenital papilla which bulges into the cloacal lumen. On tracing the uterus I found, contrary to expectation, that there was a complete occlusion of its aperture into the cloaca, the bulging ventral wall of the papilla being covered by a single layer of cells Although very careful examination of the series of sections revealed no sign of an opening from the uterus, the Wolffian ducts could be seen opening separately into the cloaca posterior to the occluded uterine opening.

The breeding habit of *Gastrotheca*, unique among Amphibia, is well known[2], and as the specimen examined was a breeding female, the complete occlusion suggests that the uterine aperture may close up after spawning.

I have also observed a similar occlusion in two adult Leptodactylid frogs, namely, *Leptodactylus pentadactylus* (Laurenti) and *Eleutherodactylus nubicola* Dunn, measuring 130 0 mm. and 35 0 mm. respectively. Both appeared to have spent ovaries and well-developed oviducts. An examination of the serial sections showed a complete occlusion of the uterine openings which appeared to have occurred after spawning. It should especially be noted that in *E. nubicola* the two uteri become confluent as soon as they touch each other ventrally to the posterior level of the kidneys, and also that the two Wolffian ducts unite with each other posteriorly. The common Wolffian duct thus formed runs for about a millimetre and a half before opening into the cloaca posterior to the occluded opening of the common uterus. In *L. pentadactylus*, however, both the uteri and the Wolffian ducts run separately throughout their course as in ranid frogs.

It would appear from the above observations that the Müllerian ducts open into the cloaca with the onset of the breeding phase and close up some time after spawning. The exact time and method of closure cannot, however, be indicated from the material at hand.

Attention may be directed here to a recent statement by Parker[7], referring to the abdominal pore in the yellow perch (*Perca flavescens*), that "All the evidence so far obtained, however, leads to the conviction that no such pore exists in the adult fish and that the opening through which the eggs are discharged represents a true, although temporary, rupture. . . . After oviposition the opening closes rapidly and in time disappears." This, by analogy, supports my observations, and raises the fundamental question whether there may not be a closing of the oviducal (uterine) aperture into the cloaca after oviposition in all lower vertebrates. It is hoped that the publication of this note may arouse interest in the study of this problem.

I take this opportunity of thanking Mr. A. Loveridge (Museum of Comparative Zoology, Harvard University), Dr. C. M. Boggert (American Museum of Natural History) and Dr. W. G. Lynn (Catholic University of America, Washington), who kindly sent me the specimens upon which my observations are based. It is also my pleasant duty to thank Prof. J. Ritchie for giving me facilities to work in his laboratory and for reading this note.

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Oct. 5.

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Micronucleus of *Epistylis*

WHILE studying the cytology of species of *Epistylis*, it was noticed that the nuclear apparatus of this ciliate presented certain interesting features. The macronucleus of *Epistylis* is a large and band-shaped body, staining deeply with all nuclear stains, and especially with Feulgen. The micronucleus is a small spherical structure situated in the neighbourhood of the macronucleus. The staining reactions of the micronucleus in two species of *Epistylis* show a significant difference. In *Epistylis articulata* From., the micronucleus is easily discernible as a deeply staining body. In *E. plicatilis* Ehrbg., on the other hand, the micronucleus gives a thoroughly negative reaction to Feulgen. Sometimes there are one or two minute granules which stain pink, but the rest of the nucleus is unstained. The difference is all the more striking because in the same mass culture both species were present, and they were treated together in the matter of fixation and staining.

Since Feulgen is the most specific nuclear reaction known, and is selective to one type of nucleic acid, the desoxyribose or thymonucleic acid, it appears that, so far as staining reactions are an indication, the desoxyribose nucleic acid content of the micronucleus of these two species is different. This is very interesting, for we believe that this is the first time the micronucleus of two species of the same genus of a ciliate is seen to exhibit a differential nucleic acid content. Whether on the analogy of the metazoan nucleus this difference between the nucleic acid of the micronuclei of the two species of *Epistylis* is correlated with a difference in protein content is not known.

It has long been known that the micronucleus of ciliates divides mitotically while the macronucleus is amitotic. If this means the formation of the chromosomes in one and not in the other, Painter's[1] recent observations on *Tetrahymena galeii*, where he reports the formation of "normally coiled and otherwise orthodox chromosomes" during the division of the macronucleus of this ciliate, are full of interest. This is in accordance with the staining reactions. The macronucleus gives a brilliant stain with Feulgen and should contain a large amount of desoxyribose nucleic acid, which we know is associated with the chromosomes. If the macronucleus does not form the chromosomes, then the association of large quantities of desoxyribose nucleic acid with it would need an explanation. In any event, the occurrence of desoxyribose nucleic acid in the macronucleus and its almost entire absence in the micronucleus of *E. plicatilis* is very interesting

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Oct. 3.

[1] Painter, T S, *Trans Conn Acad Arts and Sci*, 36, 443 (1945)

Man's Reaction to Mosquito Bites

DR. MELLANBY's communication in *Nature* of October 19 describes an investigation in progress on the reactions of different individuals to mosquito bites. These investigations could provide an opportunity to test another matter which might lead to results of far-reaching importance.

Biting insects have their preferences. Some will only attack one host species. Thus there are fleas, bird-lice, ticks, etc., which feed exclusively on one bird or animal species. The yellow fever mosquito with which Dr. Mellanby is experimenting will bite, I believe, only a few birds and animals. Coming to man, it is commonly asserted that biting insects have a marked preference for some individuals, and I know people who believe that they have never been bitten by any insect. Is this true, or is it merely that they have reached Stage IV in Dr. Mellanby's reaction list and neither feel the bites nor suffer any after-effects ? Tests could be carried out on those who make such claims and, if there is any marked preference shown by insects, I suggest that it might be a matter of the utmost importance to discover the reason. If, to simplify the problem, it were found to be due to the presence of minute quantities of some substance in the blood, the possibility might arise of injecting ourselves with a substance that would make us unattractive to biting insects.

In measuring the importance of this line of inquiry, we can bear in mind three things : (1) that in the world as a whole more premature deaths are probably brought about annually by the direct and indirect results of insect bites than from any other cause ; (2) that the bites of many insects, such as midges, are a matter of extreme discomfort even though they may cause no ill-effect ; and (3) that vast sums of money are expended annually both in attempts to destroy biting insects and in connexion with the illness they cause.

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THE question of the relative attractiveness to biting insects of different individuals is an interesting one. It was considered possible that some individuals would be relatively or completely unattractive to mosquitoes, and some experiments were initiated by the Army Malaria Research Unit during the War. I was responsible for carrying out the entomological side of this investigation. Working with *Aedes ægypti* and *Anopheles maculipennis atroparvus*, we never found any person who was completely ununattractive; in fact, when hungry mosquitoes were given the opportunity of biting, they appeared to feed on every individual with equal readiness. It should be noted that in these experiments no alternative source of food was available.

It is more difficult to carry out satisfactory experiments in which mosquitoes are given a choice of individuals on which to feed. A considerable number of experiments was, however, carried out with volunteers in cages exposed to *Aedes ægypti*. I was unable to discover any consistent preference for any particular person or any consistent avoidance of another.

Dr. Bristowe suggests that the apparent differences in the attraction of individuals may be due to their giving different reactions to the bites. I think that is the main explanation. The delayed reaction to bites is very much more troublesome than the immediate, and thus those in Stages I and II are much more conscious of a mosquito nuisance than those in Stages III and IV Thus, if two individuals are exposed to mosquitoes on several consecutive days, the one who gives the delayed reaction may imagine that every bite which is itching on a particular occasion has been recently inflicted, though they are the result of attacks on the preceding three or four days.

I believe that eventually we shall find that there is some individual difference in the attractiveness of individuals to mosquitoes and other biting insects, but that it will not be an absolute one or sufficiently important to suggest a method of control. So far those cases which have been carefully investigated tend to minimize the importance of this factor.

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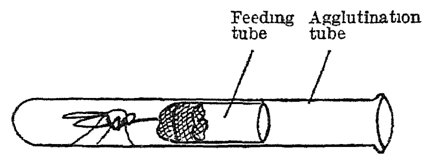
A Technique for Feeding Adult Mosquitoes

ADULT mosquitoes of both sexes can be persuaded to take a considerable variety of foodstuffs, including fruit juices, milk, sugar solutions and various blood preparations. Some interesting lines of inquiry are suggested by the inability of such species as *Culex fatigans* to produce eggs on any diet other than whole blood taken by normal biting, while other species, such as *Aëdes ægypti*, can produce viable eggs on defibrinated or citrated blood. In the course of a number of experiments at Yaba with various blood preparations, only one *Culex fatigans* produced any eggs. These were very few in number and were never laid. They were discovered only on post-mortem examination. The mosquito had received one meal of citrated guinea pig blood followed by several meals of glucose. It has been found repeatedly that the same species will produce many more eggs on a meal of avian blood than on one of mammalian blood.

Feeding techniques based on the use of a pipette, such as those of Hertig[1], Karibov[2], Macgregor[3], Kadletz and Kusmina[4] and Vainshtein[5], are tedious and require considerable manipulative skill. Nor does it appear that blood taken in this way undergoes the same process of digestion as when it is taken in the normal manner. Methods in which the food is exposed on an open surface of wool or gauze, such as those of Russell[6], and Roy and Ghosh[7], or taken through a membrane (Totze[8], Yeoli[9]), are excellent for feeding a number of mosquitoes simultaneously, but do not allow of the individual control required by some experiments. The technique described below has the advantage of simplicity and has been found particularly useful in transmission work with virulent virus, since each mosquito is kept under constant observation and the risk of escape is minimized. At Yaba it has been found possible to infect male *Aëdes ægypti* with neurotropic yellow fever virus administered as a suspension in defibrinated guinea pig blood, and to recover considerable quantities of virus after a fortnight's incubation.



The mosquitoes to be fed are allowed to emerge from the pupa in ordinary serum agglutination tubes closed by a plug of cotton wool or gauze through which the water is poured off after emergence. The food is administered on the end of a half-inch feeding tube cut from glass tubing of external diameter such that it slides easily into the agglutination tube. A suitable surface on which to place the food is provided by pushing a small circle of linen gauze down the inside of the feeding tube and allowing it to project in the form of a cap. The food is dropped on this cap from a pipette and the feeding tube is then pushed down the agglutination tube towards the mosquito. The success of the method appears to depend mainly on choosing a suitable interval between emergence and feeding. The optimum time may be expected to vary with temperature. Approximate times which have been found suitable in West Africa are as follows: *Culex fatigans*, 72 hours; *Aedes ægypti*, 60 hours; *Aedes luteocephalus*, 48 hours.

Culex fatigans has proved particularly suitable for experimental work, as it is prolific, feeds well, and is of such a size that its movements in the tube are slowed down, although it is not unduly cramped.

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Sept. 30.

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Browsing of *Patella*

During a recent investigation of *Gigartina stellata* which has been carried out at Millport, Isle of Cumbræ, I have been struck with the relationship between the limpet (*Patella vulgata*) and the seaweed, and have observed effects very comparable with those described by Mr. N. S. Jones[1] This work is being described in more detail elsewhere, and will, I think, confirm the observations of Jones, Orton, Eslich and others that *Patella* is able to browse on young algal growths, and, by the 'glades' that it forms in an algal community, may considerably lessen the algal covering on that part of the shore.

As Mr. Jones points out, this is a point of foreshore ecology that may be worthy of more attention than it has hitherto received.

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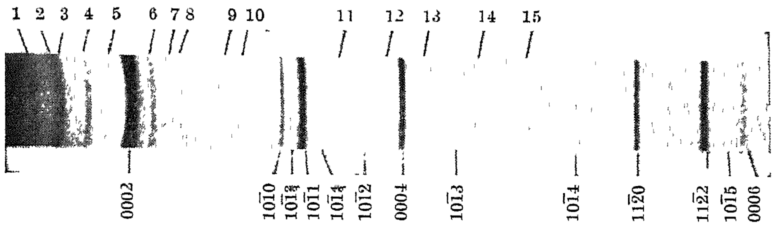
Oct. 31.

[1] *Nature*, **158**, 557 (1946).

Structure of Graphite

Laidler and Taylor[1] directed attention to the presence of lines in the X-ray diffraction photographs of graphite which could not be explained by the structure proposed by Bernal[2], and by Hassel and Mark[3]: these lines are given by graphites from many different sources, natural and artificial. Similar extra lines on electron diffraction photographs of graphite had been observed by Finch and Wilman[4]. Edwards and Lipson[5] thought that they may be caused by anomalies in the structure of graphite similar to those found in cobalt[6], but occurring at regular intervals, and proposed a new structure which would account for these extra lines[7]. In this, the flat, honeycomb net planes are stacked parallel to each other, but instead of having the *ababab* sequence of the Bernal structure, they have an *abcabc* sequence: this gives a unit cell with a c-axis one and a half times the usual one. From intensity data they calculated that this new structure represented about 14 per cent of the graphite, the remainder being made up of 80 per cent of the ordinary structure and 6 per cent of a disordered structure. It is interesting to note that this new structure was the first structure suggested for graphite, by Debye and Scherrer[8] in 1917.



The structure of graphite, however, does not yet appear to be fully elucidated. Powder photographs of graphite have been obtained containing a number of lines which cannot be explained on either of the two structures mentioned. These lines are fainter than those observed by Taylor and Laidler, but their occurrence is as general; all the natural and artificial graphites so far examined give these lines. The illustration shows a typical photograph, obtained by doubling the normal exposure time; the background scatter was reduced by passing pure, dry hydrogen through the powder camera and placing a thin sheet of aluminium foil between the specimen and the photographic film The sample from which the photograph was obtained had been purified as follows. It was extracted exhaustively with hydrochloric acid followed by hydrofluoric acid (final ash content 0 07 per cent) and then heated *in vacuo* to 2,300° C. and maintained at that temperature for half an hour. An extruded specimen 0·5 mm. diameter was photographed in a 19-cm diameter powder camera using cobalt $K\alpha$ radiation. A list of $\sin^2 \theta$ values for the extra lines on this film is given below The lines were much weaker than the normal graphite lines, so that no attempt has been made to assess their relative intensities Their positions were measured with a measuring instrument[9] specially designed for the purpose. A number of very pure artificial graphites (ash content < 0 05 per cent) have also been examined and all show these extra lines

Line No.	θ	$\sin^2 \theta$	Line No	θ	$\sin^2 \theta$
*1	9 38	0 0266	9	21 32	0 1322
*2	10 66	0 0342	*10	22 44	0 1456
*3	10 98	0 0363	11	28 41	0 2263
*4	12 68	0 0482	12	31 39	0 2713
*5	13 96	0 0582	13	33 71	0 3080
*6	16 79	0 0834	14	36 82	0 3591
7	17 81	0 0935	15	39 72	0 4082
8	18 40	0 0996	16	67 30	0 8511

* Double lines mean values given.

The lines marked with an asterisk are double and each consists of two well-defined separate lines. In every case the angular separation is 0 20°, which makes it unlikely that they are separate reflexions. Furthermore, they were examined on a photograph taken in a camera of different diameter (9 cm.): in this case, taken as separate lines, their diffraction angles differed slightly, but definitely, from those of the same lines on the film from a 19-cm. diameter camera; taken as pairs, the mean values were exactly the same. The 0002, 0004 and 0006 lines of the ordinary graphite structure were also double, and this has been explained by Nelson and Riley[10] as being due to preferred orientation of crystals in the specimen. This seems to suggest that the extra lines are due to a structure closely related to the ordinary structure and that the extra double lines may be $000l$ reflexions. The layer-lattice structure of graphite makes it susceptible to modification by alteration of the sequence of layers. A preliminary examination of boron nitride, which has a similar layer-lattice structure, indicates that its spectrum also contains extra lines.

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Single Scattering of Fast β-Particles by Protons

We have recently taken some eight hundred pairs of photographs corresponding to about 124 metres of track of β-particles, of energies from 0·5 to 1·1 mV., in a mixture of 80 per cent hydrogen and 20 per cent oxygen, contained in an expansion chamber Assuming that the scattering of the β-particles in oxygen is similar to that of the adjacent element nitrogen, for which results have already been obtained[1], the elastic scattering of these β-particles through angles greater than 20° by protons is found to be in agreement with Mott's theory The theory predicted that about one such deflexion was to be expected; actually two cases were observed. The statistical fluctuations were therefore large, but it may be inferred that there is no serious discrepancy between existing theory and experiment for the collisions of protons and electrons of this energy.

As in the previous work with nitrogen, no examples of inelastic collision of electrons and protons were observed

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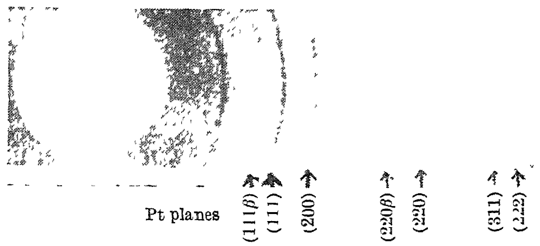
X-Ray Study of Noble Metals Dispersed in Borax- and B_2O_3-Glasses

In a previous communication[1], it was shown by us that alkali halides such as lithium, sodium, potassium, rubidium and cæsium chloride dissolved in fused boric oxide giving a homogeneous glass. X-ray examination of these glasses reveals sharp diffraction lines due to the dissolved alkali halides together with a few foreign lines which cannot be identified with any known borates of the metals. These foreign lines are largely present in glasses containing chlorides of alkali metals of low atomic numbers, but are absent with rubidium and cæsium halides. It was found later that these foreign lines are due to a variety of anhydrous crystalline B_2O_3, first studied by Cole and Taylor[2], in the case of boric oxide glasses, and to anhydrous $Na_2B_4O_7$ in the case of borax glasses.

The manner in which the alkali halide lattice exists within the non-repeating meshwork of boric oxide and borax glasses requires elucidation. Accepting Warren and Zachariasen's views about the structure of these glasses, one would be led to suggest that a new lattice is formed within the hollows of the cages formed by the B—O—B triangular bondage. But in such a case the electrostatic forces between the ions should be diminished, as also probably the short-distance repulsive forces, on account of the shielding action produced by a medium of higher dielectric constant necessitating an enlargement of the lattice. Preliminary experiments by Majumdar and Palit[3] seemed to point to such a conclusion, but later work has shown that the spacings are almost unaltered in the glass.

An interesting case has been found with gold and platinum dispersed in boric oxide and borax glasses. The samples were prepared by first evaporating solutions of auric and platinic chlorides separately in a platinum crucible and then igniting, whereby the noble metals were obtained in a finely divided state. The reduced metals were then heated with specially



purified anhydrous B_2O_3 and $Na_2B_4O_7$ respectively at 800°–1,000° C., until thoroughly homogeneous (slightly coloured) masses were obtained The crucible was then chilled and the solid extracted. Each piece of glass was examined under the polarization microscope for optical isotropy The glass was then powdered, inserted in a capillary tube, and a Debye–Scherrer photograph taken with a circular camera (radius 3 90 cm.) and a Hadding tube with copper anti-cathode. The exposure varied from 8 to 10 hours. Photographs were also taken of pure gold and platinum wires and the prints compared. A typical print of platinum dissolved in B_2O_3-glass is reproduced The following table gives the distance x in cm. between two similar lines:

x	3 35	3 65	4 0	4·70	5 225	5 30	6 10	7 95	8 95
Nature	w	s	r w	m	s	w	s	w	s

x	9 55	10 80	11 40	15 80	16 50
Nature	w	s	w	s	s

w = weak, r.w = rather weak, s = strong, m = moderate.

By trial and error method, the constant for $K\alpha$ (1·539 A.) is found to be 0 1954, and for $K\beta$ (1·389 A.) 0 1756 Hence the spacing a_0 for platinum dissolved in glass works out as follows:

$$\text{for } K\alpha,\ a_0 = \frac{1{\cdot}539 \times 10^{-8}}{2 \times 0{\cdot}1954} = 3\ 938\ \text{A.},$$

$$\text{and for } K\beta,\ a_0 = \frac{1{\cdot}389 \times 10^{-8}}{2 \times 0\ 1756} = 3{\cdot}950\ \text{A.},$$

the mean value, 3·944 A., being in good agreement with the standard value for platinum, namely, 3·910 A.

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Cerium Tungstate as a Semi-Conductor

Both Zambonini[1] and Beintema[2] claim to have prepared tetragonal bipyramidal crystals of cerium tungstate, $Ce_2(WO_4)_3$, by fusing a precipitate, using sodium chloride as a flux. Subsequent work by Sillen and Sundvall[3] showed that the compound was actually $NaCe(WO_4)_2$ of scheelite-type structure. Tammann[4] has also described a cerium tungstate, but the only observations made were on the change with temperature of electrical resistance of powdered compacts. The resistance of a pellet 1 mm. thick and 14 mm. diameter was given as 40,000 Ω at 600° C. and 1,700 Ω at 800° C.

In an investigation which required the use of fired mixtures of cerium oxide (CeO_2) and tungstic oxide

(WO_3), a number of samples were found to give X-ray powder photographs suggestive of a single phase. In particular, the mixture $2CeO_2.3WO_3$ (which can be expressed approximately as $Ce_2(WO_4)_3$) was found by microscopic examination to be quite homogeneous, consisting of small clear, round, yellow crystal fragments with no evidence of cleavage or natural faces The birefringence was much lower than that of wolframite. Since the optical interference figure showed the crystals to be biaxial positive, implying either orthorhombic, monoclinic or triclinic symmetry, indexing of the X-ray powder diffraction pattern was difficult and examination of suitable single crystals was necessary. These were obtained, up to 1·5 mm. in diameter, by cooling the fused mixture of oxides very slowly in a platinum boat, to about 20° below the melting point (1,060° C. ± 10° C.).

Oscillation photographs about the three crystallographic axes were taken using copper radiation. Laue photographs showed that the symmetry was monoclinic. The following unit cell dimensions were obtained: $a = 11{\cdot}49 \pm 0{\cdot}04$ kX.; $b = 11\ 70 \pm 0{\cdot}04$ kX.; $c = 7\ 81 \pm 0\ 03$ kX.; $\beta = 109{\cdot}8° \pm 0{\cdot}5°$.

The presence of hkl spectra only when $k + l$ was even, the presence of hol spectra only when both h and l were even, and also the presence of oko spectra only when k was even, established the space group as either $C_{2h}^6 - A_2/a$ or $C_s^4 - Aa$, depending on the crystal class. Measurements of three well-developed crystals using a single-circle goniometer showed the habit to be pyramidal. The most prominent forms observed, although not always completely on the same crystal, were $\{\bar{1}11\}$ and $\{111\}$ followed by $\{100\}$ and $\{\bar{2}11\}$. The morphological evidence and the absence of a discernible pyroelectric effect (using the liquid air method of Wooster[5]) point to the crystal class $2/m$. The space-group, therefore, is probably $C_{2h}^6 - A_2/a$.

The chemical analysis of a second batch of the tungstate, prepared in the same way as the single crystals, was found to be as follows:

Constituent	Expressed as	% Found	Theoretical % in $2CeO_2.3WO_3$
Tungstic oxide	WO_3	66 4	66 9
Rare earth oxides	CeO_2	33 5	33·1
Ferric oxide	Fe_2O_3	0 17	—
Alumina (by diff)	Al_2O_3	1 52	—
Alkalis	Na_2O	0 13	—
	Total	101 72	100·0

Electrical resistance measurements made with a pressed pellet (14 mm. diameter × 5 mm. thick) which was pre-sintered at 600° C. showed no simple conductivity temperature relationship below 1,000° C., but above this temperature the conductivity obeyed the relation $\sigma = A \exp -B/kT$ with $B = 14{\cdot}6$ electron volts, the resistance being less than 5 ohms just below the melting point. The resistance was lowered in oxygen, a characteristic of an electron-defect lattice[6].

The specific gravity of the powder ground to pass a 350-mesh sieve was found to be $6{\cdot}65_3$ 20/4° C. The number of molecules of $2CeO_2.3WO_3$ in the unit cell was calculated to be 3 83 (≈ 4). The departure from a whole number may be due either to slight inaccuracies in the determination of the unit cell dimensions or to the presence of sealed pores in the crystals.

The crystals were found to have a hardness between 3 and 4 on Moh's scale. Unlike scheelite, they do not fluoresce with X-rays. When heated in air or in an evacuated silica tube (the material is inert to silica) they show a reversible colour change, from orange at 500° C. to deep red at 900° C. This reversible colour change is shown by at least two semi-conductors, hexagonal ZnO and monoclinic $PbCrO_4$, both of the electron-excess type[6].

A list of the interplanar spacings and intensities of the powder pattern has been prepared which is being submitted for inclusion in the next supplement of the A.S.T M. X-ray Diffraction Data Cards.

Thanks are due to Mr. A. M. Adams, who assisted us in the experimental work.

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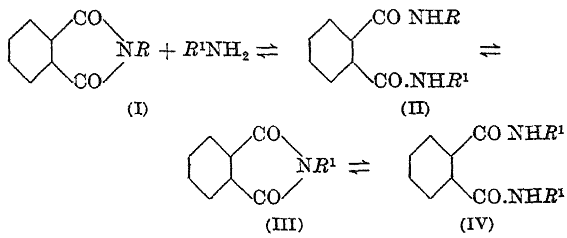
The Reaction Between N-Substituted Phthalimides and Primary Amines

We have shown that treatment of phthalimide with a primary aliphatic amine such as methylamine gives NN′-dimethylphthalamide in high yield[1]. The controlling step in the reaction sequence was found to be the remarkable ease of conversion of N-methylphthalamide into N-methylphthalimide, which occurs rapidly and quantitatively on shaking with water at room temperature. In view of the recent communication of H. J. Barber and W. R. Wragg[2], we now record some observations made in a continuation of our previous work.

When an N-substituted phthalimide (I) reacts with a primary amine, the reaction can be expressed as follows:



The variation in the nature of the reaction products is illustrated by the following examples. Treatment of N-β-aminoethylphthalimide (I) with benzylamine yields NN′-dibenzylphthalamide (type IV). Treatment of N-β-acetylaminoethylphthalimide with benzylamine gives N-β-acetylaminoethyl-N′-benzylphthalamide (type II); and treatment of N-methylphthalimide with ethylene diamine yields N-β-aminoethylphthalimide (type III). A previous example of the latter type of reaction has been described by Ristenpart[3], who converted N-β-bromoethylphthalimide into N-methylphthalimide by treatment with methylamine.

The reaction sequence extends and includes our original observations, and, in agreement with Barber and Wragg, it gives a ready explanation of the isolation by Mosher[4] of 8(γ-phthalimido-propylamino)-6-methoxyquinoline (type III) from the product of the reaction between N-γ-bromopropylphthalimide (I) and the base *R*36 (8-γ-aminopropylamino-6-methoxyquinoline) employed in the preparation of the antimalarial substance *R*63.

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Hypochlorite Sterilization of Metal Surfaces Infected with Bacteria Suspended in Milk

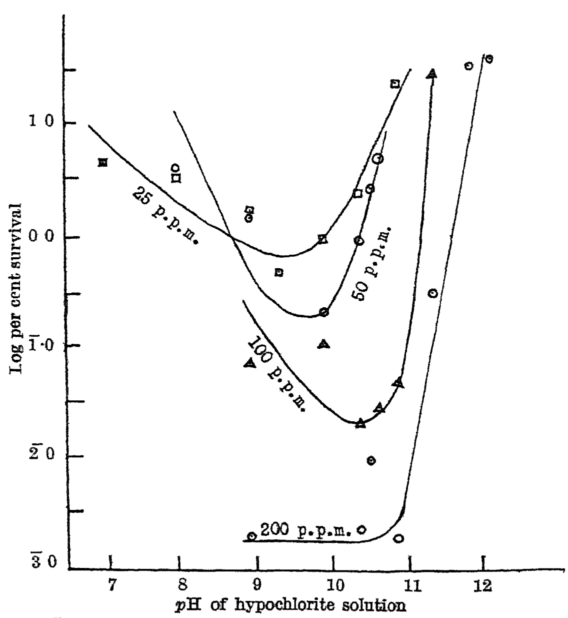
IT was first shown by Holwerda[1], and later confirmed by Levine and his co-workers[2,3], that *in solution* hypochlorite is germicidal by virtue of the undissociated hypochlorous acid.

Neave and Hoy[4], working with metal surfaces artificially infected with a suspension of *Staph. aureus* in milk, found that the *p*H of hypochlorite solutions had little effect on the germicidal rate providing it did not exceed 11.

Using a technique essentially similar to that of Neave and Hoy and working with suspensions of *Staph. aureus*, thermoduric micrococci, and spores of *B. subtilis*, we found that the latter when dried in a milk film on a metal surface behaved identically as when suspended in solution, that is, solutions of low *p*H were more germicidal than at higher *p*H. Thus the percentage survivals of spores when in contact with a solution containing 50 p.p.m. available chlorine for 5 min. was 0 2, 2·5 and 80 at *p*H values of 7, 7·85 and 9 respectively.

The two vegetative organisms, on the other hand, behaved very differently, showing optimum 'kills' at *p*H values of 9 4, 9·8, 10·5 and 11 with concentrations of 25, 50, 100, 200 p.p.m. av. cl. respectively.

We suggest the following explanation, which is in keeping with the observed facts. The living protein-like cell wall of vegetative bacteria, as distinct from the refractile cell wall of spores, is able to adsorb a protein film derived from the milk and perhaps organic matter of the medium. The hypochlorite solution before it can reach the vegetative cell has to react with this protein film, forming a 'chloroamine'. The survival curves obtained with the various solutions used appear to agree with a 'chloroamine' theory rather than hypochlorite. Charlton and Levine[2] have observed that monochloramine is more germicidal than hypochlorite at *p*H values above 9 5. Thus keeping the time of contact constant at 1 minute, an increase in concentration results in a higher concentration of 'chloroamine', which produces a higher 'kill', as illustrated by the graph. The contact time with the solution containing 25 p.p.m. av. cl. was 2 min At 1 minute it would not have cut the curve for 50 p.p.m. av. cl. It also satisfactorily accounts for the greater survival of bacteria below *p*H values of approximately 9·5.



SURVIVAL OF VEGETATIVE BACTERIA ON METAL SURFACES

Metcalf[5] has observed that at *p*H 14 monochloramine was completely hydrolysed. The increased survivals shown in the graph are probably due to hydrolysis of the 'chloroamine' due to increasing *p*H. It would thus appear that sterilization of surfaces by hypochlorites in the presence of milk and organic matter is largely due to the properties of a 'chloroamine' produced by the interaction of hypochlorite with some of the proteins. The importance of employing a detergent of not too alkaline a character in conjunction with hypochlorites, for example, in sterilization of dairy utensils and perhaps crockery, is obvious, and for efficient sterilization it would appear that the *p*H of the combined solution should not exceed 10–11.

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A Simple Method of Demonstrating the Pressure of Sound

SOUND, in common with other forms of radiation, exerts a pressure on the surface on which it impinges. Measurements of this pressure have been made by Altberg and others by means of sensitive torsion balances. While measurements necessarily involve a certain degree of elaboration, a simple demonstration of sound pressure can be given without difficulty A small hole is made in the base (or even in the side wall near the base) of a cylindrical resonator which is filled with smoke. On presenting an appropriate tuning fork, smoke issues from the hole in a thin but definite stream, thus demonstrating the steady pressure that sound exerts. The experiment provides an attractive demonstration of an important property of radiation.

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RESEARCH ITEMS

Auto-antibody Concept

A. TYLER (*Proc. U.S. Nat Acad. Sci.*, 32, 195; 1946) has found that the serum of the snake *Heloderma* is capable of neutralizing the venom. Auto-antivenin was also found in the extract of liver but not in extracts from the venom gland, pancreas, kidney or spleen. The antivenin was found in the globulin fraction of the serum. The results are discussed in relation to biological and genetical problems.

Mitotic Hormone

H. H. DIXON (*Sci. Proc Roy. Dublin Soc.*, **24**, 119, 1946) provides illustrations of the fact that where nuclei of *Fritillaria imperialis* are not enclosed in a cell wall there is a synchronization of mitosis. For example, the nuclei in the cytoplasm lining of the embryo sac can be seen to be arranged in bands; the first bands are in prophase, and are followed in succession by bands of nuclei in the succeeding stages. The early stages of endosperm formation show similar formation. The author points out that the obvious synchronization, contrasted with its absence in nuclei enclosed in cell-walls, suggests that a hormone or chemical which stimulates mitosis is controlling the stages of mitosis. The estimated rate of travel of the chemical would indicate that it is crystalloid in nature.

Ambrosia Fungi

WOOD-BORING insects known as Ambrosia beetles feed upon certain fungi which grow in their galleries. Shirley Webb (*Proc. Roy. Soc. Victoria*, **57** (N.S.) Pts. 1 and 2, 57; 1945) has investigated these fungi, as they occur in Australia. *Leptographium Lundbergii* and two species of sporogenous yeasts belonging to the genus *Endomycopsis* are the species involved. Ambrosia fungi from different parts of the world belong to the genus *Leptographium*. The question as to whether the sporogenous yeasts serve the beetles as direct food, or whether they stimulate growth of the other species, is discussed. It is suggested that *L. Lundbergii* is the conidial stage of *Ceratostomella ipis*.

Botrytis Rot of Gladiolus

A SERIOUS corm rot of the gladiolus in Australia is caused by a fungus identical with *Botrytis gladioli*. G. C. Wade (*Proc. Roy. Soc. Victoria*, **57** (N.S.) Pts. 1 and 2, 81; 1945) shows that the fungus enters through the cut stem or the old corm. It spreads along the vascular bundles to cause extensive rotting, and can also infect the leaves and flowers. The fungus responds to increasing carbohydrate content in the presence of vitamins or plant extracts. It destroys the phloem before the xylem and forms an indicator pigment around the invading fungus. Control may be effected by dipping corms in corrosive sublimate or various proprietary dips.

Spore Discharge in *Daldinia concentrica*

THE fungus *Daldinia concentrica* is a conspicuous Pyrenomycete on dead ash wood. It is shown by C. T. Ingold (*Trans. Brit. Mycol. Soc.*, **29**, Pts. 1 and 2, 43; May 1946) to be a succulent xerophyte capable of spore discharge over a long period of dry conditions. Ascospores are violently ejected to a horizontal distance of 1·0–1·2 cm., and the stroma decreases in density from about 1·0 to 0·2–0·3 during a period of about 16–26 days in dry air. The succulent tissue of the stroma beneath the hard outer crust evidently acts as a reserve of water which appears to have an effect upon the duration of spore discharge. When part of it is removed, spore ejection ceases after a shorter period. A photo-electric method of measuring the density of spore suspensions was used in the investigation.

East Greenland Pack-ice

FLUCTUATIONS from year to year in the amount of arctic pack-ice are well known, but there is no consensus of opinion as to progressive changes towards more or less. F. Nansen could find no evidence of changes in climate, at least since the Middle Ages, in Greenland, and Th. Thoroddsen could not trace any climatic changes in Iceland. Dr Lauge Koch has made an exhaustive study of historical records of the ice of East Greenland and Iceland (*Meddelelser om Gronland*, **130**, No 3. Kobenhavn) and has come to different and definite conclusions as to changes that have occurred in the amount of pack-ice. These changes must have had correlations in climate. His conclusions may be thus summarized: from 800 to 1200 there was scarcely any summer ice near Iceland and the southern half of Greenland; the amount increased until 1400 and then again decreased until 1600, when a rapid increase began which culminated about 1900 with large quantities of pack-ice during the summer near Iceland and southern Greenland; from 1920 to 1939 there has been little ice in these seas. The evidence is naturally confined largely to summer conditions. The volume is well illustrated with maps and fully documented.

The Cedartown, Georgia, Meteorite

STUART H. PERRY, associate in mineralogy, U.S. National Museum, has described the iron meteorite ploughed up at Cedartown at an unknown date, but prior to 1898 (*Smithsonian Mis. Coll*, **104**, 23; 1946). It weighs $25\frac{1}{2}$ lb and is lenticular in shape, its greatest dimensions being 9 in. × 11 in The greatest thickness at its centre is about 3 in., and this diminishes to a thin edge all around. It was partially disrupted by its flight through the air, as a result of which it has a fissure extending inwards about 5 in. An analysis by E. P. Henderson showed that its percentage composition was as follows: iron, 94·02; nickel, 5·48; cobalt, 0 22; phosphorus, 0·30; sulphur, 0·04; chromium, 0·02. The house in which the meteorite was stored for some time was burned, and it may be assumed that it reached a temperature of about 560° C., but the normal microstructure showed no appreciable changes in consequence. This and other facts are consistent with experiments which have shown that changes in a body of this nature are produced only by prolonged heating, and the house which was burned was destroyed within an hour—too short a period of heat to effect any noticeable alterations.

Coppered-Tungsten Hard Glass Seals

VACUUM-TIGHT seals through hard glass with bare tungsten wire are difficult to make because leakage often occurs along the fine longitudinal cracks in the tungsten wires. A. L. Riemann (*J. Sci. Instr.*, **23**, 121; June 1946) describes a process which overcomes this difficulty. The tungsten wire is first provided with an adherent and structurally sound sheath of copper, which flows into and fills up the cracks, and then the coppered wire is sealed into the glass apparatustus. The coppered-tungsten seal requires a glass of slightly greater thermal expansivity than that suitable for bare tungsten. The process consists of six operations, all of which are described in detail. They are: (1) mounting and cleaning, (2) preliminary plating, (3) fusion in hydrogen, (4) main plating, (5) borating, and (6) beading and sealing up. A formula is derived giving the optimum thickness of copper coating to suit a particular glass, or the optimum glass expansivity to suit a given composite wire. Particulars are given of several successful seals made with wires of different diameters in $C9$ glass, uranium glass and Corning 704 glass, of expansivities 3·75, 4·1 and $4 \cdot 9 \times 10^{-6}$ per degree centigrade respectively.

Electric Contacts between Metallic Bodies

No satisfactory mechanism has as yet been proposed for the passage of current through electrical contacts between metallic conductors. Those so far advanced have been able to produce reasonable results only for contacts which can be regarded as gaps of very small width of not more than a few angstroms. Gaps of much larger width can, however, operate as good contacts, and judging from data relating to metallic powders and thin films, the electrical conductivity of such contacts apparently increases with rise in temperature. An explanation of these phenomena is suggested in a theoretical paper by J. Frenkel (*J. Physics U.S.S.R.*, 9, 489; 1945), in which the electrical contact between two metals is treated as a gap through which the electrons pass from one metal to the other by means of thermionic emission. The potential barrier, in virtue of the image forces, is lowered by reducing the gap, and thus the passage of the current is facilitated. The electrical conductivity, σ, of the gap is defined as the ratio of the resultant thermionic current through the gap, when an external homogeneous electric field E is applied, to the product of E and the width of the gap. For small values of E, σ is shown to be independent of E, as in the case of an ordinary conductor obeying Ohm's law. The expression derived for the increase of σ with rise in temperature is exactly similar to that found for the electrical conductivity of a semi-conductor, and on the assumption that the main part of the effective resistance is due to a large number of contact gaps between the metallic particles, phenomena observed with fine metallic powders and thin layers may be understood. A more exact and detailed calculation of the contact resistance based on the mechanism described is to be published in a special article later.

Analysis of Vibration Problems

Considerable attention has been devoted during recent years to studies of the characteristics, measurement and reduction of vibration as it occurs in engineering equipment, with particular reference to the avoidance of noise during operation. In a paper recently published (*J. Inst. Elect. Eng.*, 93, Part 2; Oct. 1944), A. J. King discusses each of these different aspects of the problem and gives a comprehensive survey of the methods of vibration measurement now available, and advice on the principles to be followed in prescribing measures for its reduction. He also describes a moving-coil co-ordinate potentiometer apparatus developed for measurement, over the frequency range 10–110 cycles/sec., of the dynamic stiffness and damping of resilient materials, for use in reducing the transmission of vibration, and gives data for a range of representative materials.

Development of High-Voltage Gas Pressure Cables

The development of high-voltage cables of the oil-impregnated lapped paper type, in which the effective electric strength of the dielectric is raised by subjecting it to a high gas pressure, has been proceeding in Great Britain for many years, and lengths of this type of cable are now in successful operation. The general principles involved in the design of joints and sealing ends for such installations have been discussed in a recent paper by L. G. Brazier (*J. Inst. Elect. Eng.*, 93, Part 2; Oct. 1946), with particular reference to a cable operating at 132 kV. and a gas pressure, provided by dry nitrogen, of 200 lb./in.^{2}. It is characteristic of laminated paper structures that their electric strength in the direction of the laminations is much less than that across them. This relative weakness against longitudinal stress is not removed by the application of gas pressure, and accounts for the special difficulties involved in designing joints capable of withstanding voltages of the high order mentioned above.

Methyl Bromide as a Delousing Agent

The adoption of this compound as a delousing agent was the outcome of a series of experiments made to determine the value of available fumigants for delousing clothing and equipment. They were carried out by the U.S. Bureau of Entomology and Plant Quarantine at the request of the office of the Surgeon General of the Army. The foregoing title is that of Circular 745 (1946) of the U.S. Department of Agriculture written by R. Latta, H. H. Richardson and J. B. Kindler. After preliminary trials methyl bromide was selected as the fumigant best suited for the purposes required. At the time of the entry of the United States into the Second World War louse-borne typhus was a matter of vital concern for Army welfare. The advantages of methyl bromide are that it does not stain clothing, leaves no odour, is non-inflammable and does not react with articles, especially those of plastics, that might be part of the soldier's outfit. The dosage adopted for complete killing of all louse eggs was at the rate of 9 lb. per 1,000 cu. ft. of space for half an hour at 60° F. Methyl bromide fumigation proved to be the most potent weapon for mass delousing in the field during the early part of American participation in the Second World War, until the wholesale application of insecticidal powders proved the potentialities of that method.

The Deep Minimum in the Light Curve of Nova Herculis 1934

F. J. M. Stratton (*Mon. Not. Roy. Astro. Soc.*, 105, 275; 1945) has offered an explanation of the deep minimum in the transition stage of the light-curve of Nova Herculis 1934 and also of Nova Cygni 1942. It is suggested that the vanishing of the absorption lines as well as the weakening of the continuous spectrum are due to an obscuring cloud passing between the earth and the nova, the opaque cloud forming inside the outer shell and passing across the central star, thus obscuring both the star and the inner shells. There is a short discussion on the nature of the obscuring cloud, and reference is made to Chandrasekhar's suggestion in 1939 that ejected matter from a nova might change its physical state and become particles or molecules. Some support for this view is afforded by the spectrum of Nova Pictoris 1925, and, while no final explanation is given on the nature of the obscuring cloud, it seems possible that it has some connexion with the outflowing atoms of carbon, nitrogen and hydrogen.

VARIATION OF COSMIC RADIATION WITH FREQUENCY

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MEASUREMENTS of cosmic radiation at 40, 90 and 200 Mc./sec. have been carried out recently in Britain, using directional aerial systems, and the observations at 40 and 90 Mc./sec. have been confirmed and extended to cover the full 360° of galactic longitude by various observers stationed in ships at other latitudes.

For comparison between observations obtained with different aerial radiation patterns, it is useful to reduce the results to some common denominator which is conveniently the equivalent noise temperature T_e of a hypothetical aerial having a beam-width narrow compared with the radiation pattern of the source.

If the aerial beam is rotated at right angles to the plane of the Galaxy, the observed noise temperature of the aerial T_o, as well as T_e, may be expressed as functions of galactic latitude φ, and 'energy widths' φ_o and φ_e can be assigned to these functions, defining the energy width of a noise temperature distribution $T = A(\varphi)$ as $\frac{1}{T_p}\int A(\varphi)d\varphi$, where the suffix p denotes the peak value of T. It may then be shown that T_{ep} is given by $T_{op}.\frac{\varphi_o}{\varphi_e}$. It is possible to deduce φ_e from φ_o, given a knowledge of the aerial radiation pattern, but with the rather wide beams which had to be used at 40 and 90 Mc./sec. (about 35° in the vertical plane and respectively 70° and 35° in the horizontal plane to half power) the accuracy obtainable is rather poor. Observations were reasonably consistent with a figure of 35° for φ_e derived from the contours obtained at 64 Mc./sec. by J. S. Hey, J. W. Phillips and S. J. Parsons[1], and this value has been used as a basis for Fig. 1, which shows the variation with galactic longitude of the noise increase associated with the equatorial plane of the Galaxy with respect to the noise-level obtained when the aerial is directed away from the galactic plane. The results of Hey, Phillips and Parsons, replotted on the same basis, have been included for comparison, and it will be noticed that there is a good measure of consistency between results at the various frequencies, except that the peak in Cygnus is largely smoothed out at 40 and 90 Mc./sec. owing to the use of relatively wide beams.

In the region of minimum noise, the probable experimental error at 40 and 90 Mc./sec. is of the order of 2 or 3–1, and too much significance should not be attached to the apparent peak at 190° which has not appeared in all the sets of observations and is inconsistent with the contours obtained by Reber[2]. It has been assumed that φ_e is constant, and this appears to be roughly true for the variation with galactic longitude according both to Reber and to Hey, Phillips and Parsons, although the contours of the latter suggest some narrowing in the region of Cygnus. According to Reber, φ_e appears to be of the order of 18° at 160 Mc./sec., and this apparent narrowing with increase of frequency is supported by the 200 Mc./sec. measurements, though not conclusively owing to the low noise-level at this frequency and consequent difficulty of making accurate observations.

The full-line curves of Fig. 1 have been plotted from one particular set of observations obtained at lat 52° N. and involving probable errors somewhat smaller than those of the majority of the results available. The aerial beams were directed horizontally and, taking account of ground reflexion, were estimated to intersect the Galaxy at a few degrees above the horizon. Observations at angles of less than 60° between the horizon and the plane of the Galaxy have been ignored in order to simplify the calculations.

The dotted curve is based, as regards shape, on records obtained by S/Lt. Cummings, during a voyage to Australia, for the condition when the planes of the Galaxy and the horizon were coincident it is also a reasonable mean curve through a large number of observations made with the planes at approximately right angles.

The variation of noise-level with frequency is illustrated by the upper curve in Fig. 2 for 350° galactic longitude, and the slope of the curve gives the relation

$$T_{ep} \quad \propto \quad \frac{1}{(\text{frequency})^{2\cdot 7}}.$$

It is considered that this is just near enough to an inverse cube law for the difference to be attributable

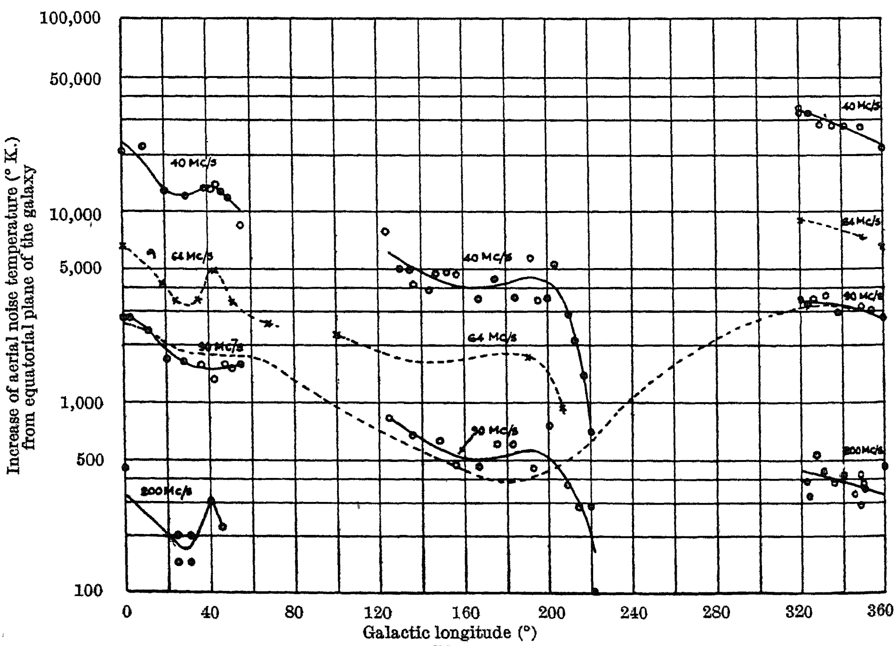

Fig. 1

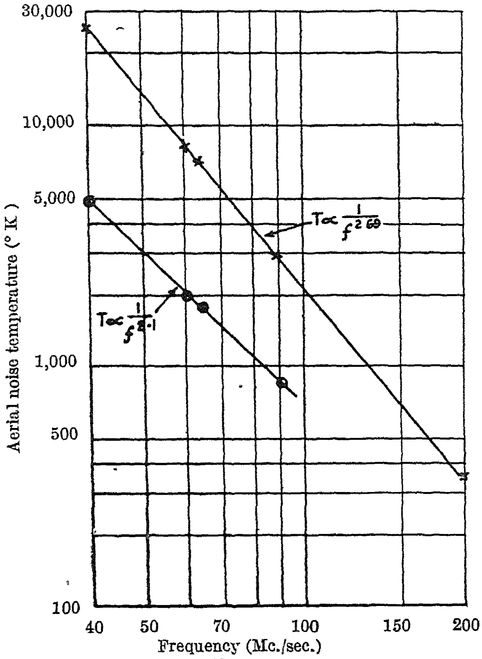

Fig 2

to possible errors in observations. No significant variation of index with galactic longitude has been noticed. It will be appreciated that the index is not dependent on the value assumed for φ_e, although it is affected by any variation of φ_e with frequency.

The minimum noise-level was found to be considerable. It is plotted in Fig. 2 as a function of frequency, and is of the form

$$T_e \quad \propto \quad \frac{1}{(\text{frequency})^{2\cdot 1}};$$

the index is likely to be high, if anything, owing to the rather poor bearing-discrimination of the 40 Mc./sec. aerial Aerial side lobes could account for an error of at most 5 per cent in index. Mismatching at the receiver input can cause an error in the observed minimum temperature by altering the receiver noise-level, but this possibility was eliminated by careful matching in the case of the measurements used as the basis of Fig. 2. Other possible sources of error are terrestrial interference too weak to be detected by ordinary methods, and zero shift during the measurements. The latter has been minimized by averaging the readings obtained over a 24-hour period, and reasonable consistency between measurements with various installations enables interference to be excluded except as a possible cause of some of the fluctuations experienced, which usually amounted to not more than +60 per cent relative to the absolute minimum. It is considered, therefore, that the apparent difference in law is sufficiently well founded to be worth recording.

The subtraction of the minimum level in deriving Fig. 1 has the advantage of avoiding the above sources of error, and is also required by the present lack of evidence to justify recording the minimum level as galactic noise. The difference in frequency-law implies either the existence of two kinds of noise, or of frequency-selective attenuation by interstellar matter. In the absence of a suitable theory, and in view of the apparent constancy of frequency law with galactic longitude, the attenuation hypothesis appears unlikely, and it is suggested that the minimum noise-level may perhaps be accounted for by secondary radiations from the earth's atmosphere; on the other hand, an aerial directed away from the plane of the Galaxy must possess some noise 'temperature' of galactic and some of extra-galactic origin, and an estimate of these effects may be essential to a full explanation of the observations.

In view of the much-discussed hypothesis that galactic noise is analogous to the noise associated with solar flares, a comparison of the variation with frequency for the two cases is of interest. The data available for solar noise are rather scanty, but unpublished measurements by H. M. Bristow and his colleagues indicate that the variation with frequency is very much more rapid than that shown in Fig. 2, thus tending to support the contention of Greenstein, Henyey, and Keenan[3] that this is an entirely different type of phenomenon.

I am indebted to many of my colleagues for their assistance in carrying out the measurements described, and in particular to H Suhl for his valued collaboration in the mathematical aspects of the work.

[1] Hey, J. S., Phillips, J. W., and Parsons, S. J., *Nature*, **157**, 297 (1946).
[2] Reber, G, *Astrophys. J.*, **100**, 279 (1944).
[3] Greenstein, J. L, Henyey, L. G., and Keenan, P C., *Nature*, **157**, 806 (1946)

ENZYMIC DECOMPOSITION OF *A*, *B* AND *O* SPECIFIC BLOOD-GROUP SUBSTANCES

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SCHIFF[1] observed that cultures and culture filtrates of certain strains of *Clostridium welchii* possess the power to inactivate the blood-group *A*-substance contained in peptone and human saliva. The decomposition was considered specific for *A*-substance. We have examined a number of crude *Cl. welchii* filtrates for their capacity to destroy the specific blood-group substances, but have found them disappointingly weak. Through the kindness of Dr. W. E. van Heyningen, who has supplied a number of *Cl. welchii* (Type *A*) culture filtrate preparations partially purified with reference to collagenase (κ-toxin)[2], it has been possible to study the action of the enzymes contained in these preparations on the blood-group substances. The filtrates contained collagenase and hyaluronidase[3], and in most specimens α- and θ-toxins were also present. The substrates used were preparations of *A*-substance obtained from hog gastric mucin[4] and *A*-, *B*- and *O*-substances which had been isolated from human pseudomucinous ovarian cyst fluids[5]. The human *A*- and *B*-substances showed no significant *O* specificity. The *A*-substance isolated from hog mucin, although electrophoretically homogeneous at pH 4·0 and 8·0, nevertheless is composed of two mucoids, one of which possesses *A* specificity and the other *O* specificity. The mixed material, which is usually referred to as 'hog mucin *A*-substance', cannot be separated readily into its serologically specific *A* and *O* components by any of the simple chemical or physical techniques employed so far, but full details of this aspect of the dual specificity of hog mucin '*A*-substance' and of preparations of *A*- and *B*-substances isolated from the saliva and gastric juice of persons belonging to groups *A*, *B* and *AB* will be discussed elsewhere.

Overnight incubation (37°) of the enzyme preparation with the blood-group substances in the presence of toluene destroys almost completely their specific serological characters as measured by the usual iso-agglutination inhibition technique. It was observed, however, that whereas the enzyme preparations after heating for one hour at 56° fail to decompose the gastric mucin *A*-substance or the human *A*- and *B*-substances, they nevertheless rapidly and completely destroy the *O* characters of the hog mucin preparation and of the human *O*-substance. It would appear, therefore, that there are at least two enzymes present in the partially purified and concentrated *Cl. welchii* filtrates, one of which is thermolabile and decomposes the *A*- and *B*-substances, the other is thermostable and attacks and destroys the *O*-substance only.

One *Cl. welchii* filtrate examined was found to decompose the *A*- and *B*-substances but to be without action on the *O*-substance. Under controlled conditions of growth and heat inactivation, it is therefore possible to obtain an enzyme preparation which will destroy either the *A*- and *B*- or the *O*-characters of the blood-group substances.

The destruction of the serological activity of the *A*- and *B*-substances by the enzyme preparations is prevented by an anti-serum produced against *Cl. welchii* filtrates. An anti-serum of this kind contains α-antitoxin, θ-antitoxin, anti-hyaluronidase and anti-collagenase, and almost certainly possesses antibodies against other unidentified antigenic components present in the original culture filtrates. The anti-serum, however, fails to inhibit the action of the thermostable enzyme responsible for the destruction of the *O*-substance. This is conceivably due to the poor antigenic quality of the enzyme when in competition with the antigenically active α- and θ-toxins, hyaluronidase and collagenase.

Certain preparations of *Cl. welchii* α- and θ-toxins have been examined which have had no action on the specific serological characters of the *A*- and *B*-substances, and it may be accepted, therefore, that these toxic components have no action *per se* on the *A*- and *B*-substances. Preparations of α- and θ-toxins, however, which decompose the *O*-substance, continue to do so after these toxic components are completely neutralized by α- and θ-antitoxin respectively. The α- and θ-toxins have, therefore, probably no action on the serologically specific *O*-character of the *O*-substance of human or animal origin. A preparation (1,000 v.r.u. per ml.) of *Cl. welchii* hyaluronidase kindly supplied by Dr. Rogers was found to be without action on the *A*- and *B*-substances, but rapidly and completely destroyed the serological activity of the *O*-substance, presumably by virtue of the heat-stable enzyme that is common to most *Cl. welchii* filtrates and not by the action of hyaluronidase, for preparations of streptococcal, staphylococcal and testicular hyaluronidase fail to decompose the *A*-, *B*- or *O*-substances.

It has been found that most of the enzyme preparations fail to destroy the *A*-activity of the human or animal *A*-substance when this character is measured by the hæmolytic inhibition test. The hæmolysis test is generally believed to measure the 'Forssman' or heterophile component of the *A*-agglutinogen, and is accepted as measuring a different, although closely related, serological property of the *A*-substance from that determined by the iso-agglutination inhibition technique

A number of preliminary observations have been made on the chemical changes brought about by the action of a mixed enzyme preparation on the '*A*-substance' derived from commercial hog gastric mucin, which is composed of *A*- and *O*-substances. The optical rotation of the material changes from a dextro rotation, $[\alpha]_{5461} + 11°$, to a lævo rotation, the reducing power, expressed as glucose, rises from less than 0 5 per cent to about 10 per cent, and there is a rapid fall in the relative viscosity (η) of the solution from 2 9 to a value only slightly greater than the enzyme buffer mixture (1·0) The enzymic inactivation of the *A*-substance is accompanied by an increase in primary amino-groups, estimated by van Slyke's procedure, from a value less than 1 per cent of the total nitrogen of the preparation to about 13 per cent in the hydrolysed material. Similarly, α-amino-acids, equivalent to rather less than this amount of the total nitrogen, are liberated during the decomposition.

The experiments are being extended in an attempt to relate the different chemical changes observed with the action of single enzymes, and the specific serological characters with known chemical constitution. The use of enzymes to degrade other serologically active mucopolysaccharides and mucoids is under investigation.

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THE NUFFIELD FOUNDATION

THE first report of the trustees of the Nuffield Foundation, covering the three years ended March 31, 1946, recapitulates the main objects of the Foundation, and indicates briefly the general policy and procedure which have governed the drawing up of the programme for the years 1944–45 to 1949–50 covering five main fields: the medical, the natural and the social sciences, fellowships and similar awards and the care of the aged poor. Total grants made by the Foundation during these three years amount to £882,820, and the policy and details of grants in the particular fields are described further in separate sections of the report.

In regard to medical sciences, the Foundation seeks to assist, first, the proper understanding, definition and maintenance of the optimum conditions of health in varying human circumstances, and secondly, the proper relation between preventive and curative medicine. The Foundation has co-operated in the fulfilment of the University of London's plans for the creation of an Institute of Child Health by endowing the whole-time professorship to be held by the director of the Institute; but, in view of the sums made available by the Government for distribution by the University Grants Committee in aid of medical education, the Foundation does not propose, for the present at least, to make any further grants in support of such departments. After approaching, early in 1944, the Universities of Durham, Glasgow and Manchester and learning of their plans for developing departments of teaching and research in industrial health, the Foundation decided to offer grants totalling £40,000 each to Durham and Glasgow and £70,000 to Manchester, spread over ten years, to enable the universities to develop their schemes as soon as suitably qualified staffs could be secured The Universities shared with the Foundation the view that such departments must work in the closest co-operation with the Factory Department of the Ministry of Labour and National Service, the Industrial Health Research Board and local industries. The University of Manchester has now created a full professorial department, and the University of Durham has instituted a Department of Industrial Health as a first step towards the realization of a scheme for a combined department dealing with both social medicine and industrial health in close association with the existing department of child health. At the University of Glasgow, a sub-department of industrial health has been created inside the Department of Public Health. A grant has also been promised by the Foundation towards the research side of the combined industrial health and rehabilitation scheme at Slough, while in the field of dental health grants have been offered to the Sutherland Dental School, Durham, the Guy's Hospital Dental School, the Turner Dental School, Manchester, and the School of Dentistry at the University of Leeds. Grants have also been made to the University of Oxford in aid of the Nuffield Laboratory of Ophthalmology, and for research on nasal catarrh at the University of Manchester and the Manchester Royal Infirmary.

In regard to the natural sciences, the main concern of the trustees is to encourage and assist basic studies in universities by providing resources in advance of normal university standards, and during the present period most attention has been given to the physical sciences. Grants have been made to the Department of Physics, University of Birmingham, in aid of research to be carried out in Prof. M. L. E. Oliphant's department; to the Department of Natural Philosophy, University of Glasgow, for research work which Prof. P. I. Dee is developing in nuclear physics; to Birkbeck College, London, for the research laboratory on biomolecular studies which is being established under the direction of Prof. J. D. Bernal; and to the Department of Physics, University of Manchester, to expand and improve the technical laboratory services for research work on cosmic rays under Prof. P. M. S. Blackett. Grants to the Clarendon Laboratory at Oxford amounting to £64,000 over eight years will be an extra endowment for additional research fellowships, special technical assistants and the purchase of special research equipment and material. A grant of £1,500 a year for five years has been allotted to the Cavendish Laboratory for a special research fellowship for Dr. E. Orowan to enable him to continue his work at the Laboratory and to contribute to the cost of his work on fundamental problems of the metallic state. The Foundation has also placed at the disposal of the University of Cambridge a grant of £10,000 over a period of five years towards the cost of a joint investigation by the School of Agriculture and the Laboratory of Engineering on the mechanical properties of soil. This grant is intended to meet the salaries of qualified scientific assistants, laboratory assistants and the provision of special material and equipment

In regard to the social sciences, which the Foundation interprets as implying disinterested scientific study of the structure and operation of human society, of the part played by individuals and groups of individuals in social organisations, and of the impact and effects on individuals of social institutions and relations, the trustees have so far been able to do little more than settle the broad outlines of the policy to be followed. It is intended that the funds earmarked for this purpose shall be used mainly in assisting selected universities to improve their staff and facilities for social and economic research, particularly for the realistic and quantitative investigation of social and economic problems. Where possible, encouragement will be given to investigations involving team-work by experts in different fields. In selecting universities, the trustees will look in the first place for men and women interested in realistic research and capable of building up vigorous research schools. Occasionally support will be given to the teaching and research activities of non-university bodies of high academic repute, and grants promised during the period covered by this report include an annual grant of £3,000 for five years to the general budget of the National Institute of Economic and Social Research, a similar grant to the Population Investigation Committee towards its programme of research into population problems, and grants to a total of £10,000 over five years to be used for scholarships at the National Administrative Staff College to students of merit who, without assistance, could not attend the College.

Describing the policy of fellowships, scholarships and similar awards to which the trustees proposed to devote a substantial portion of the Foundation's income, the report refers to visiting lectureships, seconding and interchange of teachers and others, and collaboration with the Dominion Students' Hall Trust as included in the programme. Schemes already instituted include the Nuffield medical fellowships in social medicine, child health, industrial health, and psychology, Nuffield dental fellowships and scholarships, an offer of £5,000 towards the interchange training scheme of the British Committee for the International Exchange of Social Workers and Administrators, the Colonial Service Scholarships and a similar, limited scheme for officers of the Sudan Government Service, a programme of Dominion medical travelling fellowships to facilitate post-graduate training and experience in Great Britain, awards for six Maltese demonstratorships and for a number of Alderney training bursaries.

In regard to care of the aged poor, the Foundation has sought first to provide itself with a proper basis of knowledge on which to decide future action, and has initiated a survey of the problems of ageing and of the care of aged people, under a committee of which Mr. B. Seebohm Rowntree is chairman, with a medical sub-committee on the causes and results of ageing under the chairmanship of Dr. A. S. Parkes. A grant of £20,000 has been accepted by the University of Cambridge for an investigation at the psychological laboratory under Prof. F. C. Bartlett, which will deal with the characteristics and changes of human functions associated with different age-groups, with particular reference to adult groups.

Among miscellaneous grants, the report refers to one of £9,000 to the Imperial Agricultural Bureau to accommodate the Empire potato collection, and one of £1,500 to the Medical Research Society to permit purchase of the assets of the journal *Clinical Science* and to prevent a rise in price of the journal during the next five years.

UNITED STATES NATIONAL MUSEUM

REPORTS FOR 1944 AND 1945

THE extensive work carried out by the United States National Museum in the interest of the war effort is an outstanding feature of the report for 1944 (Washington, D.C.: Gov. Printing Office, 35 cents). Under the heading, "The Museum in War-time", the chief of the departmental services rendered are described. Some of these include the following: Dr. Kellogg's preparation (for the National Research Council) of text and illustrative matter relative to monkeys known to be susceptible to infection by malarial parasites; the supply to various organisations of the Services of information regarding the identification and distribution of mammals involved in the transmission of diseases; the provision of information relating to the habits of certain mosquitoes, mites and ectoparasites sent in for identification by various Army and Navy units, the supply (to Army and Navy medical and other training centres throughout the country) of several hundreds of specially mounted specimens of insects and Acarina species involved in human health problems; suggestions for tropical and Arctic clothing; information regarding water supply and population statistics of the Caribbean Islands, house types in Burma, and the degree of western influence in certain Pacific islands and in the Philippines; the provision of information (based on collections in the Department of Anthropology) regarding the resources of certain strategic areas, and so on.

During 1944, Dr. G. A. Cooper concluded his field studies on the stratified rocks of Sonora, and it is reported that the results of his work (to be published shortly) will assist in the location of new mineral areas. Dr. Cooper also finished field-work on a project concerned with the Devonian sub-surface geology of Illinois, and information has been obtained which will be useful for the oil development of that and neighbouring States. Other work connected with the Department of Geology included the continued supervision by W. F. Foshag of surveys for strategic minerals in Mexico.

Under the section of the report dealing specifically with the activities of the Department of Geology, reference is made to the present-day scientific value of plaster casts of type fossils—"in view of the destruction taking place in foreign museums". In this connexion, mention is made of a cast of the English Carboniferous crinoid, *Poteriocrinites crassus* Miller, received as a gift from the British Museum (Natural History). The holotype and only specimen of this was housed in the Bristol Museum, which was destroyed by enemy action during the War.

The report ends with a 28-page list of accessions, and a list of the Museum's publications issued during the fiscal year 1943–44.

The report for 1945 of the United States National Museum (25 cents) comments on the necessity for additional housing space if the progressive work of the Museum is not to be hindered. In this connexion, allusion is made to the wealth and utility of the Museum's scientific materials in the future development of American natural resources, agriculture and industry. Congress has already authorized the addition of wings to either end of the Natural History Building as soon as public building projects are possible, and now plans for separate buildings for engineering and industries and for American history have been estimated for authorization. The proposed engineering and industries building would take the place of the present arts and industries building, which is, to quote the report, "an antiquated brick structure . . . no longer suitable for modern installations in museum display".

JOHN INNES HORTICULTURAL INSTITUTION

ANNUAL REPORT

THOSE who are acquainted with the limitations of space under which the John Innes Horticultural Institution has laboured in past years will welcome the forthcoming transfer to its new site at Bayfordbury Park, Hertfordshire, already described in *Nature* (**156**, 586; 1945).

The thirty-sixth annual report of the Institution, for 1945, covers a very wide field of investigation.

The replacement of existing virus-infected, low-yielding clonal stocks of raspberries is a pressing necessity. M. B. Crane's work on high-yielding F_1 families of seedling raspberries promises to provide a rapid method of producing virus-free seedling stock of sufficient uniformity. He records that the yield of the best hybrid family is 60 per cent higher than that of a selected stock of Norfolk Giant. Further extensive trials of F_1 families planted in 1945 have been bred for greater uniformity, especially in respect to firmness and colour of fruit.

Several investigations on the tomato are in progress; A. G. Brown, working on hybrid vigour, reports in all cases considerably higher yields from F_1 families than from either parent. A breeding investigation aimed at combining high yield with early maturity is in progress. Dr. D. Lewis is endeavouring to obtain a degree of frost hardiness in hybrids derived from crosses between certain wild species of tomato, collected from high altitudes in Peru, and cultivated varieties. Messrs. W. J. C. Lawrence and J. Newall have shown, notably in tomatoes, that earliness and total yield depend to a remarkable degree on seedling treatment designed to avoid any check to rapid development. Factors of great importance are the minimizing of root disturbance by pricking out small seedlings directly into pots, and the employment of pots sufficiently large to allow unrestricted root development. Further experiments show the importance of adjusting the fertilizer balance and concentration in the seedling compost to an optimum level, and the feeding of root-bound plants with a balanced fertilizer prior to transplanting. In winter, however, the influence of reduced light intensity in glasshouses is shown to be of over-riding importance, outweighing all other factors.

The production, in certain varieties of apple, of diploid pollen by heat-shock treatment of the pollen mother cells has enabled Dr. D. Lewis to raise triploids from diploid varieties, including varieties Northern Spy and Beauty of Bath. The induced triploids have the marked advantage, in a highly heterozygous plant, of possessing a complete diploid genotype from one parent, while segregation in the female parent provides for limited variation. Triploids from Northern Spy should provide a vigorous rootstock immune to woolly aphis.

Dr. A. J. Bateman, working on the isolation requirements of crops grown for seed, has demonstrated that, in all crops investigated, contamination between adjacent blocks of varieties falls to 1 per cent or less at a separation of 150 ft., even in conditions under which it is most favoured, in both wind- and insect-pollinated crops. He suggests that growers' reports of serious contaminations over distances of furlongs or even miles are better explained by contamination in a previous generation masked by dominance or genic interaction.

Dr. C. D. Darlington, the director, refers to work on the effects of X-rays on the pollen mother nuclei of *Tradescantia bracteata* during meiosis. Low dosage (45r.) led to end-to-end association of pairs of bivalents at metaphase, due not to breakage and reunions between non-homologous chromosomes, but to crossing-over between the segments of different chromosomes usually regarded as non-homologous. Breakage and reunion do occur, but exclusively within single chromosomes, to give centric or acentric rings. This suggests that the chromosomes before meiosis appear to behave as isolated units.

Further investigations upon which reports are submitted include trials of Merton varieties of cherries and haricot beans; trials of bush and dwarf tomatoes; incompatibility in polyploids with reference to *Œnothera organensis*; mutation and the production of self-fertile fruits in sweet cherries and *Œnothera*; the action of camphor, lactic acid, D.D.T., 'Gammexane' and sulphonamides on cell division, primary and secondary pairing in polyploids; artificial drying of seeds in relation to viability and germination; interspecific sterility and incompatibility in *Rubus*; the analysis of polygenic inheritance; and breeding systems and genetic isolation with reference to certain *Antirrhinum* species.

STRUCTURE AND MECHANICS OF THE PROTOZOAN FLAGELLUM

HARLEY P. BROWN has made an important contribution to our understanding of this subject (*Ohio J. Sci.*, 45, No. 6, 247; 1945). His paper begins with an extensive and highly critical review of the great amount of work already done on the morphology of the flagellum, and more than a hundred authors are mentioned.

An account is then given of the author's own investigations using the electron microscope. The section gives useful advice as to the preparation of the specimens for this new technique, and the results are shown in twelve beautiful plates, each with a micron scale. It is concluded that each flagellum is of approximately uniform diameter throughout and consists of a denser axial core surrounded by a less dense sheath, though in *Euglena* and *Astasia* the core appears to consist of two closely approximated fibres of equal size. The sheath seems to contain, or to consist of, a spirally coiled fibre surrounding the core. The flagella of *Euglena* and *Astasia* have also, along one side, what appears to be a single row of delicate filaments extending out from the sheath, their length is about five or six times the flagellar diameter, namely, 1·5–2·0 μ. The long flagellum of *Ochromonas* bears similar filaments probably on all sides, but that of *Chilomonas* is devoid of filaments.

The mechanics of the flagellum is then considered and investigated by ingenious experiments. The motion of the flagellum was rendered visible by mounting in a viscous solution of methyl cellulose. In every case, the wave impulse travelled from the base towards the tip, in a spiral course, producing rotation of the tip. All these observations directly support conclusions arrived at by A. G. Lowndes[1]. A model flagellate was also constructed, and the author swam completely immersed, gyrating one or both arms in a relatively narrow cone. These experiments again confirm Lowndes' hypothesis, and show further that rotation of the gyrating object is not necessary for the production of a forward component, since mere gyration of an object (arm or flagellum) can produce an effective locomotor force.

It is thus shown that Lowndes was correct in stating that: (*a*) the flagellum beats in spiral undulations; (*b*) the waves of contraction progress from the base towards the tip of the flagellum, and often increase in amplitude as they progress; (*c*) the flagellum serves to push, rather than to pull, the organism through the water, although it arises from the anterior end of the body; (*d*) that rotation and gyration of the body alone may account for the locomotion of many flagellates.

This work should finally dispose of the view that the flagellum acts as a tractellum and draws the body forward. It constitutes one more reaction to the scientific stimulus produced by Gray's book "Ciliary Movement". W. R. G. ATKINS

[1] Lowndes, A. G, *Nature*, 138, 210 (1936). *Proc. Zool. Soc Lond*, 114, 325 (1944)

EXPERIMENTAL MORPHOLOGY: SHOOT APICES IN STERILE CULTURE

IN a paper of very considerable interest, Dr. E. Ball (*Amer. J. Bot.*, 33, No. 5, 301; 1946) has described the development in sterile culture of shoot apices and subjacent regions of *Tropæolum majus* and *Lupinus albus*. The work, which is directed towards the solution of problems of development and differentiation at the shoot apex, depends on a precise technique of dissection, which is described, on observations of the development of the experimental materials in synthetic culture media, and on a detailed histological examination of the growths eventually produced.

Dr. Ball has been able to show that minute apical segments, comprising the terminal meristem, will grow in culture media and eventually develop into entire plants. The shoot apex of *Tropæolum*, which has a lower respiratory rate than its subjacent tissues, will only grow into a complete plant when submerged in the agar medium. Comparable apices of *Lupinus*, which have the highest respiratory rate of the shoot, will only grow into complete plants if placed on the surface of the agar. Hence primary meristems are not all characterized by a low oxygen consumption. The polarity of shoot apices was not altered by being orientated away from the vertical position. Indeed, the evidence suggests that the shoot apex controls the geotropic response of the subjacent tissues.

Plants grown from excised apices developed normal though small vascular systems, that is, in circumstances in which the influence of the older vascular tissues had been eliminated. Such development demonstrates the independent, self-determining nature of the apical meristem.

Small segments of the tissues subjacent to the apical region grew best in aqueous medium to which unautoclaved coconut milk had been added. Those of *Lupinus* produced spherical masses that usually grew by cambium-like zones considerably beneath the original cut surfaces. Internally, this cambium produced parenchyma and very short tracheal elements, externally, it produced parenchyma and some cells that were apparently sieve-tube elements. In contrast, the subjacent tissues of *Tropæolum* had various regions of superficial cells that underwent rapid mitoses. The end result was an irregular mass of parenchymatous cells that only infrequently contained groups of tracheal elements. In neither plant did the callus give rise to roots or buds. The original polarity of these subjacent regions was not retained in culture.

The results obtained suggest that there is a decreasing capacity for growth and development on proceeding basipetally along the shoot. The indications thus are that not all living plant cells are possessed of unlimited capacity for development, full meristematic potentiality being restricted to a few tissues only. The shoot apex possesses the greatest capacity for development of the entire plant; tissues subjacent to the shoot apex possess this capacity to a limited extent only. This interpretation is contrasted with other suggestions in the literature that theoretically every living plant cell is capable of producing any cell organisation characteristic of the species.

ASTRONOMICAL TELESCOPES

PROF. H. H. PLASKETT delivered his presidential address on February 8, 1946, to the Royal Astronomical Society, taking "Astronomical Telescopes" as his subject; the address has now been published (*Mon. Not. Roy. Astro. Soc.*, **106**, 1, 80). There has been a tendency for some time to belittle the observational work that can be carried out at observatories in Britain, and some have even expressed the view that in the interests of efficiency the university observatories should be closed down. Others, while not quite so extreme in their attitude towards British climatic conditions, have suggested that if money for new telescopes should become available in Britain, these telescopes should be erected in some more or less remote part of the Commonwealth where better observing conditions prevail. Prof. Plaskett believes that these views are fundamentally wrong, and submits an alternative view under a number of headings; a brief outline of his proposals follows.

Most branches of astronomical research show the necessity for a large telescope in Britain, and Prof. Plaskett selects the physical interpretation of stellar spectra as an example. Although we cannot ignore the contributions made by astronomers and physicists in other countries, the interpretation of stellar spectra was primarily a British achievement; but the research was seriously handicapped because of the lack of a large reflector. It was impossible to apply the theory of Fowler and Milne to the determination of the temperature and pressure in the atmospheres of individual stars since large reflectors, which alone can supply high-dispersion stellar spectra, were not available. As a result, the next step was taken by Russell and Adams in 1928 at the Mount Wilson Observatory with the stellar spectra obtained at the coudé focus of the 100-in. telescope. Theoretical work both at South Kensington and at Mount Wilson was carried out in the closest collaboration with observers at the place where observational and experimental material was available, and it is pointed out that if university observatories are moved from Britain to more suitable climates, the theorists will ultimately follow them. For this reason it seems inevitable that the disappearance of British university observatories as centres of observational astronomy would imply the disappearance of astronomy and related branches of science. Prof. Plaskett pleads for the establishment of at least one large telescope in Britain, and after examining various kinds of telescopes, concludes that the most suitable would be an instrument of the Schmidt type with a mirror of 74-in. aperture, suitable for both direct photography and slit-spectroscopy. The estimated cost with a number of accessories would be less than £100,000. (Reference may be inserted here to the announcement by the president of the Royal Society at the opening of the Newton tercentenary celebrations that the Government has agreed to the construction of a 100-in. reflector. See *Nature*, July 20, p. 90.)

A suitable site for such a telescope should be obtained in a place remote from any of the universities provided with their own observatories, and, as an ideal arrangement, the astronomical activity of the university and private observatories would be centralized about this telescope. While undergraduate instruction would still be continued at the various universities, graduate instruction would be carried out primarily at this "Central University Observatory". Such centralization would permit of a department for the study of applied optics which would have as its primary function the theoretical study of various forms of optical instruments. In addition, it would permit of a modern laboratory for spectroscopic research—a most important branch in connexion with future developments in astrophysics. Various suggestions are made with regard to the board of management and other matters which are merely questions of detail—easily settled once the principle of a central university observatory is admitted.

Objections on the grounds of the unsuitability of the British climate are considered, and Prof. Plaskett shows that these are very much overdone. The fact that Herschel, Lord Rosse and Common did such excellent work with large instruments suggests that seeing conditions in the British Isles are at least comparable with those prevailing in other places where large instruments are used. The infrequency of clear nights is also advanced as an argument against large telescopes; but, as Prof. Plaskett points out, the less frequent the opportunities for observation, the more efficient must be the instrument and its mounting to take advantage of these fleeting opportunities. Indeed, the very rarity of suitable nights demands the best possible instrument.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 25

INSTITUTE OF PHYSICS, LONDON BRANCH (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mr R C Oldfield "Psycho-Galvanic Reflex"

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2) at 5 30 p m —Discussion on "The Heat Pump" (to be opened by Mr J A Sumner)

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in Reynolds Hall, College of Technology, Manchester), at 5 30 p m —Symposium on "Industry and Education" *

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Manchester), at 6 15 p m —Mr Maldwyn Jones "The Impact of Plastics on the Rubber Industry"

Tuesday, November 26

CHADWICK PUBLIC LECTURE (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S W 1), at 2 30 p m —Prof H J. Collins 'Some Aspects of Structural Engineering" (Bossom Gift Lecture) *

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p m —Sir Harold Spencer Jones, F R S "Three Astronomical Centenaries, 1, Tycho Brahe, Born 1546" *

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p m —Discussion on "The Economics and Subjective Requirements of Television Picture Sizes" (to be opened by Mr D C Birkinshaw).

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W C 1), at 5 30 p m —Dr Jozef Obrebski: "Changing Peasant Culture in Poland".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 p m —Annual General Meeting. Short papers on "Polarographic Analysis".

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C.2), at 6 p m —Mr C L Hirshman "Television Picture Quality".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W 1), at 7 p.m.—Mr C N Jaques "Aircraft Instrumentation in Test Flying".

Wednesday, November 27

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C.2), at 5 p.m —Sir Stephen Tallents, K C M G "The Documentary Film" (Cobb Lecture)

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL PANEL OF THE FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 15 p m —Mr H. C S De Whalley and Miss M P. Scarr "Micro-organisms in Raw and Refined Sugar and Intermediate Products"

CHEMICAL SOCIETY, LIVERPOOL SECTION (joint meeting with the LOCAL SECTION of the ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Lecture Theatre, The University, Liverpool), at 7 p m.—Mr A. V Billinghame "The Development and Industrial Application of Wetting Agents".

Thursday, November 28

BRITISH GLACIOLOGICAL SOCIETY (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 4 30 p.m.—General Meeting, at 5 15 p m.—Dr B Cwilong "Observations on the Incidence of Super-cooled Water in Expansion Chambers and on Cooled Solid Surfaces", Dr. M. Perutz "Description of the Iceberg Aircraft Carrier and Experiments on the Bearing of the Mechanical Properties of Frozen Wood Pulp upon some Problems of Glacier Flow"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 15 p.m —Prof. N. F. Mott, F.R S.: "Problems before Theoretical Physics, 2" *

ROYAL STATISTICAL SOCIETY, INDUSTRIAL APPLICATIONS SECTION SHEFFIELD GROUP (in Room B1, Department of Mechanical Engineering, The University, St. George's Square, Sheffield), at 6.30 p.m —Mr. D. Newman: "The Efficiency of 100% Inspection".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Princes' Gate, London, S W.7), at 7 p m —Prof. G. I Finch, F R S.: "Electron Diffraction and Surface Structure".

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the University, Leeds), at 7 p.m.—Mr. M. Lipson: "Wool Research in Australia"

SOCIETY OF DYERS AND COLOURISTS, WEST RIDING SECTION (at the Great Northern Victoria Hotel, Bradford), at 7.15 p m.—Mr. M. H. Wilkinson: "The Bleaching of Animal Fibres by Modern Methods".

INSTITUTION OF STRUCTURAL ENGINEERS, LANCASHIRE AND CHESHIRE BRANCH (at the College of Technology, Manchester) — Mr. H. E. Manning: "Developments in Reinforced Concrete Cooling Towers".

Friday, November 29

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the ROYAL AERONAUTICAL SOCIETY, at Storey's Gate, St. James's Park, London, S.W.1), at 5 30 p.m.—Mr. F. M. Green and Mr. J. E. Wallington: "Aircraft Propulsion".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the College of Technology, Manchester), at 6 30 p.m.—Dr. O. L. Davies: "An Application of Statistics in Chemical Research".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at St. Enoch Hotel, Glasgow), at 7 p m.—Mr J Starkie "The Stripping of Dyed Textiles by the Use of the Hydrosulphite Compounds".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 9 p m.—Capt H L Hitchins: "Compasses—Past, Present and Future"

Saturday, November 30

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (in Reynolds Hall, College of Technology, Manchester), at 3 p m — Mr. K. A. Sherwin 'Concentration of Caustic Soda Solution"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

HEAD OF THE DEPARTMENT OF APPLIED SCIENCE AND ELECTROTECHNICS, a HEAD OF THE MATHEMATICS DEPARTMENT, SENIOR LECTURERS and LECTURERS IN SCIENCE (Physics, Chemistry, Engineering), and SENIOR LECTURERS and LECTURERS IN MATHEMATICS, at the Royal Military Academy, Sandhurst—The Secretary Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1677 (November 28).

PRINCIPAL RESEARCH OFFICER in the National Bureau for Personnel Research, Pretoria, to undertake personnel research in industry—The Scientific Liaison Officer, South Africa House, Trafalgar Square, London, W C 2 (November 30).

LECTURER IN CHEMICAL ENGINEERING—The Registrar, Loughborough College, Loughborough, Leics (November 30).

BIOCHEMIST for a research appointment in the Courtauld Institute to investigate enzymes and tissue metabolism in relation to cancer—The Secretary, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1 (November 30)

LECTURER (woman graduate) IN CHEMISTRY to agricultural and horticultural students—The Principal, Studley College, Studley, Warwickshire (November 30)

LECTURER OR ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, University College, Southampton (November 30)

SENIOR ASSISTANT TEACHER IN THE MECHANICAL ENGINEERING DEPARTMENT of the South-East London Technical Institute, Lewisham Way, London, S E 4—The Education Officer (T.1), County Hall, London, S E.1 (November 30)

ASSISTANT AGRICULTURAL ECONOMIST on the Technical Staff of the Provincial Agricultural Economics Service, and a LECTURER and RESEARCH ASSISTANT IN FARM ECONOMICS in the Department of Agriculture—The Registrar, King's College, Newcastle-upon-Tyne (November 30)

DEPUTY DIRECTOR, an AGRICULTURAL CHEMIST, a PLANT PATHOLOGIST, an AGRICULTURAL ENGINEER, and an ASSOCIATE PROFESSOR OF ENTOMOLOGY, in the Punjab Agricultural Service (Class I)—The High Commissioner for India, General Department, India House, Aldwych, London, W C 2, quoting Ref. No 238/284 (November 30).

LABORATORY TECHNICIAN IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, The University, Liverpool (November 30)

ASSISTANT for research in connexion with the nutrition and metabolism of ruminants—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (November 30).

SPEECH THERAPIST—The County Medical Officer, County Offices, Lincoln (November 30).

LECTURER IN CHEMISTRY—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex (December 2).

SENIOR ASSISTANT (with good Honours Degree in Physics or Chemistry) for day and evening Science and Telecommunication Classes (senior)—The Education Officer (T 1), County Hall, London, S E.1 (December 3).

TEACHERS OF (a) CIVIL AND MECHANICAL ENGINEERING, (b) MATHEMATICS AND PHYSICS, at the South-East London Technical Institute, Lewisham Way, London, S E 4—The Education Officer (T.1), County Hall, London S.E 1 (December 5)

LECTURER IN DAIRY FARMING at Massey Agricultural College, Palmerston North, New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W.C 2 (December 5)

LECTURER IN ANATOMY—The Registrar, The University, Manchester (December 9)

FELLOWSHIP IN MATHEMATICS which will be held jointly with a Lectureship at Trinity College—The College Secretary, Balliol College, Oxford (December 9).

LECTURER IN PHYSICAL CHEMISTRY—The Registrar, University College, Leicester (December 9).

LECTURER IN ENTOMOLOGY, and a DEMONSTRATOR IN ENTOMOLOGY —The Secretary, Imperial College of Science and Technology, South Kensington, London, S W.7 (December 9)

LECTURER to work in the Cancer Research Department of the School of Medicine on the effects of X-rays on tissues—The Registrar The University, Leeds 2 (December 11).

ASSISTANT LECTURERS IN (a) PURE MATHEMATICS, (b) PHYSICS, (c) ORGANIC CHEMISTRY, (d) PHYSICAL CHEMISTRY—The Registrar, University College, Cathays Park, Cardiff (December 15)

LECTURER (Grade IIa or IIb) in the DEPARTMENT OF BREWING AND INDUSTRIAL FERMENTATION—The Secretary, The University Edmund Street, Birmingham 3 (December 21).

PHYSICIST—The House Governor and Secretary, Royal Infirmary, Leicester (December 23).

DIRECTOR OF CANCER RESEARCH in the Medical School of the University of Otago, Dunedin, New Zealand—The General Secretary, B.E.C.C Society, 11 Grosvenor Crescent, London, S.W.1 (Dunedin, December 31).

ASSISTANT ANALYTICAL CHEMIST (male) in the Government Analyst's Laboratory in Salisbury, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (December 31).

ARCHITECTURAL EDITOR, and an INVESTIGATING OFFICER—The Secretary, Royal Commission on Ancient Monuments (Scotland), 14 Queen Street, Edinburgh 2 (January 2)

POSTS in the Imperial Agricultural Bureaux of Soil Science, of Dairy Science, of Horticulture and Plantation Crops, and of Pastures and Forage Crops (including Field Crops)—The Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S W 1 (March 1).

DIRECTOR in the Imperial Agricultural Bureaux of Animal Breeding and Genetics, and of Forestry—The Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S W 1 (March 1)

SENIOR LECTURERS at the Natal University College in MATHEMATICS (STATISTICS) in Durban, in CHEMISTRY in Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

ASSISTANT AGRICULTURAL ECONOMIST, and an INVESTIGATIONAL OFFICER—The Registrar, The University, Bristol 8

LECTURER IN PHYSICS—The Registrar, Municipal College, Portsmouth

PHYSICAL CHEMIST for work in connexion with Steelmaking Slags, and Refractories—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Chemistry Department'

LECTURER IN CHEMISTRY—The Clerk, Northern Polytechnic, Holloway, London, N 7

RESEARCH CHEMIST in connexion with the study of problems of fruit and vegetable preservation—The Director, Research Station, Campden, Glos

RESEARCH ASSISTANT—The Secretaries, National Federation of Dyers and Cleaners, 7 Laurence Pountney Hill, Cannon Street, London, E.C.4.

ASSISTANT LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Head of the Electrical Engineering Department, City and Guilds College, Exhibition Road, London, S W 7

LABORATORY ASSISTANT (Grade I) in the DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N W.1.

RESEARCH SUPERINTENDENT, and an INFORMATION OFFICER—The Director of Research, Printing and Allied Trades Research Association, Charterhouse Chambers, Charterhouse Square, London, E C.1

PHYSICIST with experience in electronic instruments or electronic circuits, a PHYSICIST or ENGINEER with experience in electrical (non-electronic) or magnetic instruments, and JUNIOR PHYSICISTS or ENGINEERS with experience in electrical or electronic instrument technology—The Director of Research and Secretary, British Scientific Instrument Research Association, 26 Russell Square, London, W C 1.

RESEARCH ASSISTANT to the Wheatstone Professor of Physics, to take part in biophysics research—The Secretary, King's College, Strand, London, W C 2.

LABORATORY ASSISTANT for the Official Seed Testing Station—The Secretary, National Institute of Agricultural Botany, Huntington Road, Cambridge.

LECTURER IN PHYSICS (with subsidiary Mathematics), and a LECTURER IN MATHEMATICS (with subsidiary Physics)—The Registrar, Merchant Venturers' Technical College, Unity Street, Bristol 1.

LECTURERS (2) IN either MECHANICAL or ELECTRICAL ENGINEERING at the Bournemouth Municipal College—The Education Officer, Town Hall, Bournemouth

LECTURER IN CHEMISTRY—The Principal, Kingston-upon-Thames Technical College, Kingston Hall Road, Kingston-upon-Thames, Surrey.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Science of Relationships. Report of a Rural Life Conference held at Downe House, Newbury, January 8–11, 1946. Pp. 72 (London Rural Life Conference, C. M. House, 6 Salisbury Square, 1946.) 2s. [235

A.Sc.W Memorandum based upon the Report of the Executive Committee to the Twenty-ninth Annual Council. Pp. 16. (London: Association of Scientific Workers, 1946.) [235

Atomic Energy and Social Progress. By William Paul Pp. 32. (London: Communist Party, 1946.) 6d. [275

University of Leeds. Department of Coal Gas and Fuel Industries with Metallurgy. Report of the Livesey Professor (D.T A. Townend) for the Session 1944–45 Pp 20. (Leeds. The University, 1946.) [275

Select List of Standard British Scientific and Technical Books. Compiled at the request of the British Council. Third edition, revised and enlarged. Pp. 64. (London. Association of Special Libraries and Information Bureaux, 1946.) [305

Institute of Physics. Twenty-sixth Annual Report of the Board, 1945. Pp 24 (London: Institute of Physics, 1946.) [305

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute. Report on the Work of the School for the Year 1944–45. Pp. 44. Notes on Malaria and its Control for Planters and Miners. By Dr. G. Macdonald Pp. 61. (London. London School of Hygiene and Tropical Medicine, 1946.) [305

Ministry of Health: Social Survey. Report, New Series No. 69: Diphtheria Immunisation. By Kathleen Box. Pp. 49. (London: Ministry of Health, 1945) [305

Proceedings of the Royal Irish Academy. Vol. 50, Section A, Nos. 14, 15: Experiments on the Conductivity of Atmospheric Air, by P. J. Nolan and E. F. Fahy: The Removal of Radon from Atmospheric Air by Filtering, by P. J. Nolan and E. F. Fahy. Pp. 233–260. 2s. Vol. 50, Section A, No 16 Application of Quaternions to Lorentz Transformations. By P. A. M. Dirac. Pp. 261–270. 1s. Vol. 50, Section A, No. 17: On the Connection of Dirac's Quantum-Electrodynamics and the Theory of Radiation Damping. By P. G. Gormley and W. Heitler. Pp. 271–272. n.p. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1945.) [305

Other Countries

Bernice P. Bishop Museum. Occasional Papers. Vol. 18, No. 6 Notes on Samoan Elaterid Beetles, with Descriptions of Two New Species By R. H Van Zwaluwenburg. Pp. 95–102. Vol 18, No. 7 Aquatic Coleoptera of Oceania (Dytiscidae, Gyrinidae and Palpicornia) By J Balfour-Browne Pp 103–132. Vol. 18, No 8. New Species of Succinea from Tahiti, with Remarks on other Polynesian Species By C. Montague Cooke, Jr., and William J. Clench Pp. 133–138 Vol 18, No 9: Two New Storeus from the Philippines (Coleoptera, Curculionidae) By Elwood C. Zimmerman. Pp. 139–144. Vol 18, No. 10 The Genus *Liagora* (Rhodophyceae) in Hawaii. By Isabella Aiona Abbott Pp 145–170. (Honolulu: Bernice P. Bishop Museum, 1945) [174

Famine, Rationing and Food Policy in Cochin By K. G. Sivaswamy; and Medical Surveys, by Lieut.-Colonel T. S. Shastry. Pp x + 77 + 35 + 8 plates. (Royapettah, Madras. Servindia Kerala Relief Centre, 1946) 3 rupees [234

Report on General Survey of British Somaliland, 1944. (Colonial Development and Welfare Act, Economic Survey and Reconnaissance) Published under the authority of the Military Government, Somaliland Protectorate. Pp 12 + 17 charts. (Burao Government Press, 1945) 3s. 6d [234

Smithsonian Miscellaneous Collections. Vol. 104, No. 29: Sunspot Changes and Weather Changes By H. H Clayton. (Publication 3816) Pp. ii +29. (Washington, D.C: Smithsonian Institution, 1946) [234

A Report on the International Control of Atomic Energy. Prepared for the Secretary of State's Committee on Atomic Energy by a Board of Consultants, Washington, D.C Pp viii + 44. (Washington, D C. Government Printing Office, London H M. Stationery Office, 1946) 1s. net. [254

Abridged Scientific Publications from the Kodak Research Laboratories Vol. 20, 1938 Pp 273 + vii Vol 21, 1939. Pp 380 + vi. Vol. 22, 1940 Pp 278 + vii Vol 23, 1941. Pp 283 + vii Vol. 24, 1942 Pp. 391 + x. Vol 25, 1943. Pp. 443 + xii. (Rochester, N Y. Eastman Kodak Co, 1939–1944.) [254

Transactions of the San Diego Society of Natural History. Vol 10, No. 17: The Glossy Snake, Arizona, with Descriptions of New Sub-species By Laurence M. Klauber. Pp. 311–398 + plates 7–8 Vol. 10, No. 18 Data and Field Notes on the Desert Tortoise. By Chapman Grant. Pp 399–402. (San Diego, Calif.. San Diego Society of Natural History, 1946.) [294

Report of the Kodaikanal Observatory for the Year 1941. Pp. 4. (Delhi: Manager of Publications, 1942) 3 annas; 4d. [294

An Arithmetical Approach to Ordinary Fourier Series. By Aurel Wintner Pp 29. (Baltimore, Md The Author, Rowland Hall, Charles and 34th Streets, 1945) 1.20 dollars [294

A New Concept of Intermolecular Forces. By Richard G. Woodbridge, III. Pp. 8. (Princeton, N.J: The Author, 120 Prospect Avenue, 1946.) [294

Carnegie Institution of Washington. Year Book No. 44, July 1, 1944–June 30, 1945; with Administrative Reports through December 14, 1945 Pp. xxxiv + 12 + 196. (Washington, D.C.. Smithsonian Institution, 1945) [294

Records of the Department of Mineralogy, Ceylon Professional Paper No. 2. Ilmenite, Monazite and Zircon (Sessional Paper 6 of 1926, revised); Gems and Semi-Precious Stones of Ceylon. By D. N Wadia and L J. D Fernando. Pp. 44 + 4 plates. (Colombo. Ceylon Government Press, 1945.) [294

Carnegie Institution of Washington: Department of Terrestrial Magnetism Scientific Results of Cruise VII of the *Carnegie* during 1928–1929 under Command of Capt. J P Ault. Oceanography—4: The Work of the *Carnegie* and Suggestions for Future Scientific Cruises. (Publication 571.) Pp. vii + 111. (Washington, D.C Carnegie Institution, 1946) 1.50 dollars. [294

Annual Report of the Agricultural Meteorology Section, Indian Meteorological Department, for the Year 1944–45. Pp iii + 54. (Poona: Indian Meteorological Department, 1946.) [294

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No 189: Soils of the Berriquin Irrigation District, N.S.W. By Robert Smith Pp. 55. (Melbourne: Government Printer, 1945.) [294

Report of the Zoological Survey of India for the Years 1938 to 1941. Pp. lxxxiii. (Delhi: Manager of Publications, 1942.) 2.6 rupees; 4s. [294

Memoirs of the Indian Museum. Vol. 13, Part 3: Gobioid Fishes of India, by F. P. Koumans; A List of the Fishes known from the Andaman Islands, by Albert W. C. T. Herre. Pp 205–404. 6.14 rupees; 11s. Vol. 13, Part 4: Distribution, Host and Habits of the Indian Serphoidea and Bethyloidea. By Dr. Hem Singh Pruthi and M. S. Mani. Pp. 405–444. 2 rupees; 3s. (Delhi: Manager of Publications, 1941–1942.) [294

Colonial Institute at Amsterdam. Special Publication No. 53 (Department of Tropical Hygiene No. 16) Health of White Settlers in Surinam By Prof. N. H. Swellengrebel, in collaboration with E. van der Kuyp. Pp. viii + 118. (Amsterdam: Colonial Institute, 1940.) [25

Koninklijke Vereeniging 'Koloniaal Instituut', Amsterdam. Negen en twintigste Jaarverslag, 1939 Pp. 129 + 6 plates. Dertigste Jaarverslag, 1940. Pp. 124. (Amsterdam: Koloniaal Instituut, 1939–1940) [25

United Nations Relief and Rehabilitation Administration: Southwest Pacific Area. Proceedings of Conference of Veterinary Representatives of Far Eastern Member Governments of UNRRA and of the Military Commands, held at 52 William Street, Sydney, Australia, on 14th, 15th and 17th December 1945. Pp. vi + 82. (Sydney: United Nations Relief and Rehabilitation Administration, 1946.) [25

U.S. Department of the Interior. Geological Survey. Bulletin 945–D: Tungsten Deposits in Beaver County, Utah. By S. W. Hobbs. (Strategic Minerals Investigations, 1944.) Pp. iv + 81–112 + plates 32–40. 65 cents. Bulletin 946-A: Manganese and Iron Deposits of Morro do Urucum, Mato Grosso, Brazil By John Van N. Dorr, 2d. (Geologic Investigations in the American Republics, 1944.) Pp iv + 48 + 6 plates. 75 cents. (Washington, D.C: Government Printing Office, 1945.) [85

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INTERNATIONAL CONTROL OF NUCLEAR ENERGY

THE report on Scientific and Technical Aspects of the Control of Atomic Energy, which has been issued by the Scientific and Technical Committee of the Atomic Energy Commission*, is in some ways rather disappointing. Ignoring the possibilities of distributing denatured atomic fuel discussed by the Lilienthal Board, the report merely concludes that there is an intimate relation between the activities required for peaceful purposes and those leading to the production of atomic weapons; most of the stages which are needed for the former are also needed for the latter. Safeguards are not regarded as too difficult for the mining operations which are of special significance as the first step in these activities. Particular attention should be paid to the installations in which concentrated nuclear fuel is produced, since the product lends itself immediately to the production of bombs. Unless appropriate safeguards are taken at each of these stages, it will be difficult to ensure that no diversion of material or installation takes place.

Nevertheless, the Committee does not find any basis in the available facts for supposing that effective control is not technologically feasible; but the report does not discuss the political feasibility of control or recommend any system or systems by which effective control can be achieved. Compared with Lord Cherwell's statesman-like speech in the House of Lords on October 23, the report is strangely diffident and disappointing. There is lacking that sense of the vital necessity of reaching some working agreement to prevent the use of the atomic bomb in war which pervaded Lord Cherwell's address, like that of the utterances of so many other men of science on this subject. Lord Cherwell regards the Baruch plan as indicating a perfectly feasible approach, and he does not flinch from the difficulty that any workable scheme inevitably involves a certain surrender of that complete sovereignty which some nations are so insistent to preserve. Without international inspection, there can be no security against individual countries developing, producing and perfecting these bombs. A mere undertaking to refrain from their use will give no more security against their being used than the Kellogg Pact undertaking to refrain from war prevented the outbreak of war in 1939. Nor will a mere exchange of such information as a country chooses to divulge suffice. Either an international authority with the powers and the will to act in the case of recalcitrance must be allowed to inspect all the countries of the world, and to insist on the cessation of any obnoxious activities concerned with nuclear weapons, or we must make up our minds to an international arms race culminating almost certainly in disaster.

This central issue was very clearly put by Lord Cherwell. It is the essence of the problem which the Atomic Energy Commission has to face, and it is a

* Scientific and Technical Aspects of the Control of Atomic Energy Pp. v+42. (Lake Success, N.Y.: United Nations Department of Public Information; London: H.M. Stationery Office, 1946.) 25 cents; 1s.

fundamental reason for the Atomic Energy Act, which provides for the national control and regulation necessary for international control. That much needs to be remembered, for the attention rightly given in the debates, both in the House of Lords and in the House of Commons, to certain aspects of control as it reflects research and development, may tend to cause that fundamental purpose and reason for the Act to be overlooked.

Lord Addison's remarks in regard to research and the importance of not doing anything to prevent men of science exchanging ideas and developing scientific experiments on sound lines were in line with the Prime Minister's speech in moving the second reading of the Bill, and the undertakings which the Minister of Supply gave at the Committee stage, more particularly that a system of advisory panels of men of science would be an integral part of the administration of the Act, and that the ordinary tools of the nuclear physicist should be made exempt from its secrecy provisions. Lord Cherwell, however, was looking for constructive proposals rather than at the restrictions: he was concerned with the positive methods the Minister would use to promote research and development, and rightly warned the House of the difficulty of prosecuting research under Treasury auspices. It had been universally agreed, he said, that nuclear research could only be handled effectively on university lines, giving the head of the department the same freedom that a university professor enjoys in engaging his own staff, determining their salaries within reasonable limits, and directing their activities according to their particular aptitudes and interests.

Lord Cherwell's concluding observations were once again in line with those of American men of science. He thought it reasonable for Parliament to impose restrictions on physicists for the sake of saving humanity, but he distrusted Clause 11 as it stood as appearing to inhibit discussion even among *bona fide* colleagues, except in so far as particular topics exempted by the Minister are concerned. Finally, opposing the suggestion for a special advisory committee, he remarked that while it is important that the Ministers and Civil servants responsible for governing the country should have some knowledge of science, it is not for the man of science as such to rule, and he was confident that there were sufficient people in Parliament with scientific knowledge to make a Minister's life a burden to him if he took a line in any scientific and technical matter which is repugnant to scientific opinion.

What Lord Cherwell urged regarding the positive promotion of the development of atomic energy was even more strongly supported by Lord Samuel, who inclined to an optimistic view on early developments, and urged further its value for research both in physics and medicine. While, however, what was said in the House of Commons regarding the importance of freedom for the exchange of scientific knowledge as an essential part of scientific progress without which science will languish and die, even if in the present state of the world that condition conflicts with the interests of national and international security, was fully endorsed in the House of Lords, as already suggested, this may not be the first issue at the moment. The essence of scientific progress is, as Lord Samuel observed, freedom of communication and the interchange of ideas. It is equally important to remember, as Lord Cherwell indicated, that ethical considerations may impose some limits on the use of the scientific method, and while scientific men rightly stress the imperative necessity of an early solution of the political problem of control, there is an equal duty upon them to consider the ethical issues involved, and whether in the wider interests of science itself no less than of humanity, a halt could not wisely be called in the development of atomic energy for any purposes until the governments of the world have been sufficiently wise and realistic to work out an effective system of control.

The minimum of control is that represented by the proposals of the United States, and so long as the U.S.S.R. refuses to agree to effective international inspection, suspicion will arise. Whether the U.S.S.R. agrees or not, if the scientific and technical committee decides that control can be worked from the technical point of view, the remaining governments must see that a political body with adequate powers of inspection is established. If, for example, a world commission of experts were given the proper status by selection from all nations, with appointments irremovable except for misconduct as is the rule for judges, and the special diplomatic status which would enable them to move freely in all countries, it might be no long task for the Commission to establish full confidence in its integrity, impartiality and ability even among such nations as are at present reluctant to agree.

Meanwhile Russian opposition to the idea of an international inspectorate and to the demand for sanctions, unimpeded by any veto procedure, against any nation violating the system of control, which is a highly important part of the Baruch proposals, should not lead us to overlook that the Lilienthal plan on which those proposals were broadly based may be more limited than at first appeared. The Lilienthal Board was cautious in the claims which it made for denaturing as a safeguard, and Mr. Baruch, in presenting the American proposals, said that the public had over-estimated the value of denaturing as a safety measure, and that the use of denatured materials would always require suitable safeguards. Safe activities will, in fact, probably be limited to scientific research, including the operation of low-energy piles and the use of radioactive material as tracers, in which the quantities of active material used are so small as not to be dangerous. If atomic energy is to be developed on a large scale as a source of industrial power, some fairly close system of supervision by the international authority will be essential to ensure that the denatured material which it has supplied for those economic uses is not being 're-natured' so as to make it suitable for use in a bomb.

The difficulties in providing such a system are considerable, and even a sense of urgency and a clear political field would not make it easy for the Atomic

Energy Commission to reach a rapid conclusion. The formidable extent of the task which will face the new authority will be apparent on the most cursory consideration; and while it has been freely recognized in Great Britain and in the United States that the method of carrying out the control entails some sacrifice of national sovereignty, and it is already clear that the Government would have the support of all parties in Britain in agreeing to accept such limitations, that is not yet universal. Nor is the generous gesture which the United States has made in making its proposals been fully appreciated.

It is here that the ethical question may well arise. The United States Government is entitled to urge that such a plan cannot be put into force in a day, that it can only succeed in an atmosphere of confidence, and that that confidence must be built up gradually; nor is it reasonable to expect the United States to destroy its existing stock of weapons until such confidence exists and the system is seen to be working effectively. On the other hand, it is a reasonable claim that so long as the United States retains its freedom to produce and possess bombs, other countries cannot be bound not to produce them. That in itself makes it difficult, if not impossible, for scientific men to formulate any practical code of ethics which would proscribe further work in this field until an effective scheme of control had been formulated and was working effectively.

It is significant that at the international conference of atomic scientists held at Oxford last July, Prof. J. M. Burgers expressed the hope that an international body could be formed which would emphasize that nuclear studies should be undertaken only for peaceful ends. There can be no doubt as to the value of the pressure which a united front on the part of scientific men could exert in this matter; but at the present time their professional organisations are very far from being sufficiently comprehensive and strong enough to afford the man of science the anchorage he needs to exercise such influence. None the less, to retard the development of atomic energy even for peaceful ends for a few years might well be a small price for mankind to pay if it stimulated or accelerated the elimination of the menace which the existence of the atomic bomb will represent until a system of control has begun to function smoothly.

The Oxford conference decided that the main function of an international body at this time should be to facilitate the rapid and accurate exchange of information; and there can be no question that even if such a moratorium were feasible, one condition would be that there should be no interruption of fundamental scientific research. It would be inherent in the formulation of any code of ethics for scientific men that there must be the utmost freedom of investigation and of communication, in the printed book or periodical and in personal contact. The expenditure on the improvement of scientific communications in some of the ways considered at the Empire Scientific Conference last June, or outlined in proposals before the United Nations Educational and Scientific Organisation, of a tithe of the sums at present earmarked for the development of atomic energy, might in itself make no mean contribution to the establishment of the confidence and goodwill and the general political 'climate' in which effective control of atomic energy or of other forms of warfare can function. Prof. Mumford's recent book, "Programme for Survival", and Lord Cherwell's wise speech in the House of Lords should stir men of science in general to fresh thinking on the whole problem, and to fresh endeavour in practical leadership.

A SOUTH AMERICAN ANTHROPOLOGICAL SYMPOSIUM

Handbook of South American Indians

Edited by Julian H. Steward. (Smithsonian Institution: Bureau of American Ethnology, Bulletin 143.) Vol. 1: The Marginal Tribes. Pp. xix+624+112 plates. Vol. 2: The Andean Civilizations. Pp. xxxiii+1035+192 plates. (Washington, D.C.: Government Printing Office, 1946.) Vol. 1, 2.75 dollars; Vol. 2, 4.25 dollars.

MORE than a hundred contributors, all from the Americas, have undertaken the task of producing the five volumes of this Handbook, of which the two under review are the first to appear; a volume will be devoted to each of four cultural divisions into which South America and certain regions to the north have been divided: marginal and hunting tribes from Terra del Fuego up to north-eastern Brazil, the Andean civilizations to the west; the tribes of tropical forests and savannah in the great central areas of the sub-continent and on the east coast; and the circum-Caribbean cultures to the north and up the Isthmus to Honduras and along the Antilles to Cuba. The fifth volume, designated the comparative anthropology of the South American Indians, will contain general summaries and comparisons of the various aspects of the cultures previously detailed. An arbitrary outline, arranged to a standard sequence, has been followed by the contributors of each article, to assure proportionate brevity and facility of reference.

For each tribe there is an introductory passage, often illustrated and including a geographical sketch, followed by an account of tribal divisions and history, and sections detailing the particulars of all the activities and organisation of the tribe. The work, well described in a foreword as monumental, is intended to serve as a standard work of reference to the scholar, a text-book for students and a guide to the general reader; these aims are fulfilled by the employment of specialists in each field, who combine a certain amount of new material with a revaluation of much old.

Each article presents chronologically, in the form outlined above, the data available from earliest times onwards through four hundred years of contact with White civilization: to these archæological and historical horizons is added a foreground of ethnographical description, and in consequence post-contact change and the absorption of the tribes into European civilization are revealed and traced in as much detail as possible. Where information from these three sources is more complete, and the scale of tribal existence more considerable, such as in the Andean area, it has been found possible to sketch outlines from the earliest archæological beginnings, through the Inca period, the Spanish conquest and the post-conquest period to the present day. Such an account as this, gathering into brief but comprehensive form all the recorded knowledge on the tribe concerned, serves to present an agreeable and factual history for the purposes of all readers. In the case of certain tribes, the knowledge to be gathered is very scanty and the account necessarily brief; where, for example, interest has ceased in post-contact absorption owing to the cessation of obvious tribal custom, such an account may be contained upon one page: this, however, perfectly serves the purpose of reference.

In the first volume, the marginal tribes are put into three divisions: Indians of southern South America, Indians of the Gran Chaco, and Indians of eastern Brazil. Articles by well-known American authorities on the seven southernmost tribes include for the first time well-documented studies of the Tehuelche and Puelche of Patagonia, and a collection of the limited data available on the Poya culture. By the reproduction of illustrations from a great variety of sources, some of which are not readily available, a full presentation of archæological backgrounds is achieved, together with comprehensive historical and modern ethnographic instances. The work of Junius Bird is outstanding in this section.

One third of the first volume is occupied by a study of the Gran Chaco by Alfred Métraux. It is a full and exhaustive account of the numerous tribes of the area, including their archæology and history, and contains an extensive enumeration of sources; the many illustrations, from Métraux's material and from many other sources, help to produce an outstanding and authoritative contribution to existing works on this great area in the heart of the subcontinent. A postscript is given by an account of the present-day Indians of the Gran Chaco by Juan Belaieff.

In the remaining part of the first volume, the tribes of eastern Brazil are as painstakingly portrayed, by northern and southern American authors, the whole collection of articles using for reference a large and intricate map compiled by Curt Nimuendaju.

The second volume deals with the Andean Highlands and the Central, Southern and Northern Andes: Wendell Bennett has contributed profusely illustrated articles on the Andean Highlands and the archæology of the Central Andes, which are followed by accounts of the Cupisnique, Salinar, Mochica, Cuzco, Inca, Quechua, Aymara and Uru-Chipaya cultures. The post-contact development of Inca culture under Spanish rule is admirably analysed by George Kubler, and the modern Quechua are discussed in the light of hitherto unpublished field-work by Bernard Mishkin. In these articles the balance of archæology, history and ethnology is more evenly kept than is possible in many other instances, and examples of ancient and modern crafts and material processes are laid out in 120 plates and 48 text-figures.

Studies by Junius Bird on the North Chilean culture sequence and the historic inhabitants of the region preface accounts of the Southern Andes contributed by Bennett, Samuel Lothrop, Gordon Willey, John Cooper and other authorities. The Northern Andean region is explored in detail in articles which follow an account of Ecuador by Donald Collier, in which summaries of most recent work—including some undertaken during the Second World War—are of great interest: Collier shows, for example, on Plate 159, Cerro Narrio pottery discovered in stratigraphic testing in 1941, during which an early period and a late period were revealed, which merged into Inca. The articles on Columbia, among contributors to which is Alfred Kroeber, will be essentially supplemented by Vol. 4, dealing with the circum-Caribbean tribes, which include Lowland Columbians, Venezuelans and Antillans.

The Handbook in its entirety will prove a work of frequent reference to all interested in the study of the peoples of South America. R. W. FEACHEM

THEORY AND PRACTICE OF GOVERNMENT

Diplomacy by Conference

Studies in Public Affairs 1920–1946. By the Rt. Hon. Lord Hankey. Pp. 180. (London: Ernest Benn, Ltd., 1946.) 12*s*. 6*d*. net.

THE timing of publication of Lord Hankey's books is masterly. The publication of his Lees Knowles Lectures last year synchronized with debates on science and national defence in the light of the implications of atomic warfare. "Diplomacy by Conference" now appears almost simultaneously with a new White Paper, "Control Organisation for Defence", which gives expression to many ideas advocated by Lord Hankey in both books. The title, however, gives no indication that this new volume, like the first, is a contribution to the whole theory and practice of government under the searching demands not only of war but also of peace. The book is, as the sub-title indicates, a series of studies in public affairs, lucidly and vividly presented, and of profound interest to the ordinary citizen as to the historian or statesman. From the first, to which the book owes its title, to the last which looks to the future control of external affairs, they are illumined by shrewd comment, keen observation and a human touch, and should go far to assist in the formation of a sound opinion on the working of the United Nations Organisation, the machinery or organisation for defence or the reform of the Foreign Service. Diplomacy by conference, Lord Hankey believes, has come to stay, and his personal experience leads him to regard elasticity of procedure, small numbers, informality, mutual acquaintance, if not personal friendship among the principals, a proper perspective between secrecy in deliberation and publicity in results, reliable secretaries and interpreters as the most important factors in success, and which are the more essential the more delicate the subjects.

The first essay, based on a lecture to the British (now the Royal) Institute of International Affairs in November 1920 and afterwards printed in the *Round Table*, is followed by a study of the evolution of the British machinery of government on the level of the Privy Council, the Cabinet and the Committee of Imperial Defence. The third essay discusses the Cabinet Secretariat in its historical perspective, although written before the dramatic discovery by the late Sir John Fortescue of the papers, including many Cabinet Minutes, of King George III and George IV, as described in the second essay. The fourth essay, on the Committee of Imperial Defence, has much in common with the Lees Knowles Lectures of 1945, and it is interesting to note that Lord Hankey's stout championship of this system and firm rejection of the alternative idea of a Combined General Staff finds fresh support in the commentary included in the recent White Paper, which indicates that a close study of captured German archives demonstrates the inferiority of that system owing to the dangerous antagonisms caused by the cleavage between planning and execution nullifying any theoretical advantages of the German system. The remaining four essays briefly survey the study of disarmament, the problems of international forces, the Dominions and the War and the future of imperial defence.

Through these, as through the whole book, sounds a subdued note of hope that is most opportune in a world sadly perplexed by the wranglings in the United Nations Organisation and the Peace Conference. "If success should be slow in coming," writes Lord Hankey in his foreword, "if there are setbacks or even breakdowns, we must not be disheartened. We must remember that we are tackling problems that have baffled mankind throughout the ages. The perspective and vision of the historian are in these pages joined with the vision, judgment and administrative experience which Lord Hankey has for so long brought to the service of Britain.

R. BRIGHTMAN

INFINITESIMAL CALCULUS

Vorlesungen über Differential- und Integralrechnung

Von Prof. A. Ostrowski. Band 1: Funktionen einer Variablen. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, 8.) Pp. xii+373. (Basel: Verlag Birkhäuser, 1945.) 47.50 Swiss francs.

THE book is based on a series of lectures on infinitesimal calculus given regularly for more than seventeen years in the University of Basle. This, the first volume, contains a course intended for those whose main interest is in the applications of the calculus, and to this end it is freed as far as possible from what such students might reasonably regard as 'unnecessary subtleties'. Also the proofs of certain theorems, when too lengthy, are deferred to the second volume. Nevertheless, the course is full, clear, and sound in its foundations.

It is particularly interesting to find adopted the sequence which corresponds not only with the logical but also with the historical development, namely, the introduction of the definite integral in its own right before any mention of derivatives. Thus the following are evaluated directly from the definition of a definite integral.

$$\int_{\alpha}^{\beta} (ax + b)dx, \qquad \int_{\alpha}^{\beta} \sin x dx, \qquad \int_{\alpha}^{\beta} x^n dx.$$

Clearly such a procedure focuses attention on the fundamental nature of the integral, and also makes a direct appeal to the student's appreciation of the problem to be solved.

There are also some interesting remarks on 'learning' and 'understanding'. The usually accepted object in learning mathematics is to understand. This last word has various meanings. One can be said to understand a mathematical rule: (1) when one can apply it; or (2) when one has tested every link in the chain of reasoning by which it is devised; or (3) when one can rediscover this chain of reasoning unaided. The third sense is the one properly applicable in mathematics.

The contents of the book are as follows: (1) introductory; (2) limits; (3) continuous functions and definite integrals; (4) derivatives; (5) technique of differentiation; (6) technique of integration; (7) applications to mathematics.

The author claims to put clarity before elegance To say that he has succeeded might convey a false impression. In fact, he has combined felicitously both qualities.

The printing is excellent and there are plenty of reasonably easy exercises.

L. M. MILNE-THOMSON

THE CALIFORNIA GROUND SQUIRREL

The California Ground Squirrel

A Record of Observations made on the Hastings Natural History Reservation. By Jean M. Linsdale. Pp. xi+475. (Berkeley and Los Angeles, Calif.: University of California Press; London: Cambridge University Press, 1946.) 5 dollars.

THE Californian ground squirrel, *Citellus beecheyi* (Richardson), seems to have received more attention than any other wild animal in California, probably owing to the fact that cultivation is often followed by an enormous increase in its numbers. The observations recorded in the present work were made during the period October 1937–44, mainly on the Hastings Natural History Reservation, an area of grassland in Monterey County, California, ranging from about 1,500 to 2,750 ft. in height, and free from artificial disturbance. The author studied the habitat and general behaviour of this squirrel and devoted particular attention to the manner in which it adapts itself to changes in its environment.

The species seems to have deep permanent burrows, in which it is able to survive for several months under unfavourable conditions, but when the ground is brought under cultivation the squirrel rapidly spreads and occupies new areas. It is largely diurnal in its habits, but adults may spend as long as eight months dormant in their burrows each year. In some areas there is little indication of dormancy, but on the Reservation the season when it occurred ranged from June to March and included extremes of hot-dry and cold-wet conditions.

A special chapter is devoted to methods of communication—sounds, visual signals and scent—and to the receptive senses of these squirrels; also their mannerisms, activity and food are described in detail. This animal, like many other rodents, serves as a reservoir of the plague bacillus, but there is evidence in support of the view that latent infections do not last more than one or two months. The reproductive activities are found to be closely synchronized with seasonal changes in the climate, and only a few weeks each year are really suitable for regular activity above ground. During this period young ones appear at the surface.

The anatomy and general characters of the species are described in detail, special attention being given to the pelages and moults, as hitherto no adequate account of this has been available.

This monograph collects together a wide series of observations on very diverse aspects of the Californian ground squirrel, and the results will be of interest to students of mammalian natural history. It is unfortunate that the reproduction of the numerous photographs in some cases leaves much to be desired.

One wonders, however, especially these days of paper shortage, whether it is necessary to record observations in such very great detail. The chapter on mannerisms, for example, comprising forty-two pages, devotes six pages to attitude, nearly three pages to locomotion, and three to scratching, with a tabular summary of the parts of the body scratched and the manner in which it is performed. This is followed by five pages on wariness, seven pages on response to trapping, etc., the chapter concluding with nearly eight pages on sanitation. This is a far cry from the original observations on the animal in Captain Beechey's account of the visit of H.M.S. *Blossom* to Monterey in 1826 (vol. 2, p. 80) that "The fields are burrowed also by the ardillo, a species of *sciurus*, rather a pretty animal, said to be good to eat". Its edibility is not mentioned in the present volume. E. HINDLE

PENICILLIN AND ITS CLINICAL USES

Penicillin

Its Practical Application. Under the general editorship of Prof. Sir Alexander Fleming. Pp. xi + 380. (London: Butterworth and Co. (Publishers), Ltd., 1946.) 30*s*. net.

THIS is a general guide to the use of penicillin and is intended mainly for students, general practitioners and junior hospital medical officers. In order that every application may best be demonstrated, Sir Alexander Fleming has delegated to an imposing selection of experts the task of representing the specialized aspects of penicillin therapy. The book is, in effect, a collection of articles, and the authors, each in an understandable desire to present a complete picture, have overlapped considerably; and although not contradicting each other, there is an occasional discrepancy in dosage prescribed for the same condition by different people.

There are two sections; the first is an introduction with articles by Sir Alexander Fleming on the history and development of penicillin and on bacteriological control of therapy, and by others on chemistry and manufacture, pharmacy, pharmacology and methods of administration; the second section is purely clinical.

The clinical section contains twenty-one articles, some excellent, all covering adequately the chosen subjects, which range from war wounds through infective processes in every organ and viscus to animal diseases. A most useful article for its guide to dosage is that on generalized infections by Mr. R. Vaughan Hudson. There is a tendency by some of the other writers to give, in the reviewer's opinion, too small doses.

Sir Alexander Fleming says in his introduction: "It is almost impossible to give an overdose in the ordinary sense of the word. It is certainly possible to give much more than is necessary but in days of plenty that will not be a serious crime". The days of plenty have arrived; but their advent has escaped the notice of some. Readers should keep Sir Alexander's words in mind, follow the author using the largest doses (when a disease is covered in more than one article), and, when in doubt, multiply by five. The insistence on adequate dosage is reinforced by recent observations on the variations in character and constitution of commercial penicillin in the United States (*Lancet*, 2; 387; 1946), although this problem does not yet appear to have affected British products.

There is, throughout the book, a commendable reticence on the scope of penicillin therapy, and it is to be hoped that the medical men for whom the book was planned will benefit by this. Penicillin, like other remedies, has its limitations, and its thoughtless use where it cannot possibly be of value leads only to disrepute.

There is a number of minor errors in the text and index, and there is often produced an impression of haste in preparation. The book on the whole fulfils its purpose admirably, and there are no omissions in the enormous field of application. Subsequent editions would be vastly improved by reducing, or better removing, the many instances of overlapping. J. MARSHALL

ORNAMENTAL TREES, SHRUBS AND VINES

Trees, Shrubs and Vines for the North-eastern United States

By George Graves. Pp. xi + 267. (New York, London and Toronto: Oxford University Press, 1945.) 15*s*. net.

THIS little handbook is intended for the guidance of those who are concerned with private gardens or roadside planting in the North-eastern United States; but since the plants described in it are, almost without exception, suitable for British gardens, it deserves the notice of horticulturists in Britain and elsewhere.

The main body of the text consists of an alphabetical arrangement of genera under which some seven hundred species, varieties and garden forms are discussed. The descriptions are so framed as to give an idea of the garden value of each plant rather than to serve as an aid to identification. Many suggestions for culture and propagation are included, measures for the control of pests and diseases are suggested, and the author has not hesitated to indicate specific susceptibility to injury by frost or wind.

The technical names of plants are those found in the second edition of Rehder's "Manual of Cultivated Trees and Shrubs", and in cases of recent change both old and new names are given.

Selection from the seven or eight thousand woody plants available for planting in the area concerned can have been no light task, and there are few items the inclusion of which one could reasonably question other than × *Mahoberberis Neubertii*, which the author himself frankly disavows, and *Solanum dulcamara*. On the other hand, there are interesting references to plants infrequently seen in Great Britain, such as the fastigiate forms of *Acer rubrum*, *A. platanoides* and *A. saccharum*.

Illustrations showing both habit and details of flowers and fruits are numerous and good; and chapters giving advice on the selection and purchase of nursery plants and the pruning required for their satisfactory development add interest and value to the book. N. K. GOULD

FUNDAMENTAL PARTICLES*

By Prof. R. E. PEIERLS, C.B.E., F.R.S.

In the last fifteen years, the situation in fundamental physics has undergone a remarkable change. Previously only very few elementary particles were known; and optimistic observers, in fact, believed that it would be a comparatively simple task to elucidate the inter-relations of these particles and to account for the values of the few dimensionless constants (such as the fine-structure constant and the ratio of proton to electron mass) derivable from them. It was even said that the end of physics might be in sight.

Since then, however, discoveries of new elementary particles have followed each other at a rapid pace. No one would feel satisfied that a list which one could make up now was likely to be complete, and a great deal of further investigation is required to understand the relations between all these particles and to determine, let alone explain, the values of all constants arising from them.

The fundamental characteristics of elementary particles are as follows: mass (in units of proton mass), charge (in units of electron charge), spin $\left(\text{unit } \hbar = \frac{h}{2\pi}\right)$, magnetic moment $\left(\text{in units of the Bohr magneton } \mu, \text{ or of the nuclear magneton } \mu_N = \frac{\mu}{1830}\right)$, processes of generation and destruction, and their relation to other particles.

Elementary particles known before, say, 1930 were:

(1) *The electron*, with a mass of $\frac{1}{1830}$, a charge of $-e$, a spin of $\frac{1}{2}$ and a magnetic moment of -1 magneton.

(2) *The proton* (or hydrogen nucleus), of mass 1, charge $+e$, spin $\frac{1}{2}$. Its magnetic moment was later found to be about $+2 \cdot 8$ nuclear magnetons. This somewhat surprising result indicates that the positions of the electron and proton are not quite analogous, since Dirac's wave equation in its simplest form would predict a magnetic moment inversely proportional to the mass. A possible explanation for this apparent discrepancy will be mentioned later.

(3) *The photon*. It may appear odd to classify the photon as a particle, but it does fall well within the list of fundamental units under discussion. It evidently has no rest mass or charge, and its spin is 1. The easiest way to justify attributing a spin of 1 unit to the photon is to remember that a photon in a given state of motion, say having given momentum and direction, is still not uniquely described unless its state of polarization is specified. There are two independent states of polarization, and one might for that reason expect the spin to be $\frac{1}{2}$, which would give rise to two orientations. More detailed analysis shows that the symmetry properties of light waves require the spin to be 1, so that the photon would have, in principle, three orientations (corresponding to the three components of the field vectors describing the wave) with one of these orientations being ruled out by the conditions that the waves are transverse.

Recent work has added the following particles to this list:

(4) *The positron* was predicted by Dirac to avoid the difficulties that would otherwise arise from the solutions of his wave equation for negative energy. He imagined a state of affairs in which all conceivable states of negative energy were already filled, thus preventing, by Pauli's principle, any fresh electrons from acquiring negative energy; but occasionally one of these states might be empty, thus resulting in a lack of negative charge (hence the presence of a positive charge) and the lack of a quantity of negative energy (thus representing a particle of positive energy). The existence of this particle in cosmic rays was discovered by Anderson, and in laboratory processes by Blackett and Ochialini. It clearly must have a mass equal to the mass of the electron, a charge of $+e$, a spin of $\frac{1}{2}$ and a magnetic moment of $+1$ magneton. According to the theory of Dirac, the vacancy among the negative energy states, represented by a positron, can be filled if a negative electron is present which can jump into that vacant place. In other words, an electron and a positron together can be destroyed, with their kinetic energy and rest energy going into other forms of energy, such as radiation. Conservation of momentum requires for this two light quanta, unless the process takes place near a centre of force such as a nucleus. The inverse process is the generation of a pair of electrons (positive and negative) by the collision of two photons or by the passage of one photon through matter. Of these, only the second is of practical significance.

(5) *The neutron* was recognized by Chadwick in 1932 as a result of nuclear reactions. Its mass is approximately one unit, its charge, of course, is zero, its spin $\frac{1}{2}$ and its magnetic moment about $-1 \cdot 9$ nuclear magnetons. It was realized at once that the neutron was the missing constituent of all nuclei, and that all known facts about nuclei suggest that they consist of neutrons and protons.

In that case, the existence of beta-transformations, in which electrons or positrons are emitted by nuclei, has to be accounted for by assuming that these electrons do not normally exist inside the nucleus (which would be difficult to reconcile with the laws of quantum mechanics), but that they are generated in the process of emission, just as pairs of such particles can be generated in the pair creation referred to above, or as photons are generated in the emission of light by an atom. Conservation of charge requires that, upon the emission of, say, a negative electron, a neutron inside the nucleus is converted into a proton. Hence the number of neutrons and protons in a physical system is not fixed; only the sum of the number of neutrons and protons is fixed.

The simplest case of such a transformation would be the decay of a bare neutron into a proton, with the emission of a negative beta-ray. Present evidence about the mass of the neutron indicates that it is greater than that of a hydrogen atom, so that the process is energetically possible. It has not so far been observed, but conditions for observing it are extremely difficult.

(6) *The neutrino*. While conservation of charge is evidently in order in the process of beta-transformations, there is difficulty with the conservation of spin, since an electron of spin $\frac{1}{2}$ is produced; this cannot be balanced by any change in the orbital angular momentum of the emitting system, which is capable only of changing by integer units. There are also difficulties with energy conservation, since the observed beta-particles show a continuous spectrum, while the remaining nucleus appears to be in a definite quantum state. Those difficulties can be overcome by adopting Pauli's hypothesis of the

* Summary of the paper given to the Electronics Group of the Institute of Physics on October 22.

existence of a neutrino, that is, a particle of a mass at most of the order of the electron mass and probably less, of no charge, and spin $\frac{1}{2}$. This would rectify the difficulty with conservation of spin, and it could clearly take up the amount of energy which appears to be missing from the balance. Experiments designed to detect any action due to neutrinos have given a negative result, and it is estimated that neutrinos would have been detected in these tests if their magnetic moment were comparable to one nuclear magneton. It is, in fact, likely that the magnetic moment of the neutrino is zero.

The free neutrino must satisfy a wave equation like Dirac's equation for the electron and, in order to avoid trouble with negative energies, one has again to assume that its negative energy states are filled. Any vacancies in those negative energy states would again mean the existence of a particle which bears the same relation to the neutrino that a positron has to the electron. If the neutrino has no magnetic moment, this 'anti-neutrino' may, in fact, be identical with the neutrino itself; if there is a magnetic moment, the anti-neutrino must have a magnetic moment of opposite sign and would, therefore, be distinguishable.

The description of the processes involving the generation of an electron (or positron) and neutrino was formulated by Fermi. The inverse process of absorption of an electron by a nucleus with the emission of a neutrino should also be possible; but estimates based on the purely statistical argument of detailed balancing show that the cross-section for this process should be extremely small, of the order of 10^{-44} cm.^{2}, so that the detection of neutrinos by this means is practically impossible. The only direct support given to the neutrino hypothesis is the fact that the lack of energy balance appears to be coupled with a lack of momentum balance, detectable by the recoil of the nucleus. The neutrino theory makes a definite prediction about the amount of the extra momentum to be expected in each case, and recent experiments appear to confirm this prediction.

(7) *The meson*. The existence of a particle of a mass of the order of 200 electron masses was first predicted by Yukawa to account for the properties of nuclear forces. Neutrons and protons in the nucleus must be held together by forces which are strongly attractive at close approach but negligible at larger distances. Since there can be no direct action at a distance, these forces must be transmitted from one particle to another by some sort of field. The only types of field equations compatible with relativity are those governing also the wave function of a particle either with or without mass. Without rest mass one would obtain equations like those of the electromagnetic field, which give the inverse square law and hence are not compatible with the properties of nuclear forces. Introducing a rest mass, one obtains equations capable of giving the right kind of law, providing the mass is chosen to be about 200 electron masses. Charged particles with masses of that order were found in cosmic rays, and support was thereby given to Yukawa's theory, according to which a proton could change into a neutron with the emission of a positive meson, and the opposite change could take place giving a negative meson, provided sufficient energy was available to make up the rest energy of the meson. In cases where this excess energy is not available, the virtual possibility of this process leads to an interaction between proton and neutron of the required type.

According to this view, a proton will spend a fraction of its time tending to become transformed into a neutron and a meson. The energy needed for accomplishing this is not available, and therefore this transformation will not actually take place; but since, when accomplished, it would lead to the existence of a particle rather lighter than the proton, with a correspondingly higher magnetic moment, the brief instant when a meson tends to appear has a substantial influence on the total magnetic moment of the system. This is likely to explain the fact referred to above, that the magnetic moment is greater than one nuclear magneton. The reverse process applied to the neutron similarly accounts for the existence of a negative magnetic moment of the neutron. The same view predicts that some fraction of the charge of the proton is spread out over the meson field surrounding it, and this should lead to observable effects in processes, such as the emission and observation of gamma-rays by nuclei of light elements, which depend on the charge and current distribution. The experimental evidence on this point is not yet, however, very clear.

If this theory is adopted, the meson must have an integer spin. Theories have been advanced in which this spin is either 0 or 1, and certain difficulties connected with the magnitude of the forces at extremely close approach can be avoided if it is assumed that the forces are due to mesons with both these values of the spin. Evidence from cosmic rays seems to indicate that mesons observed at sea-level cannot have spin 1, and if mesons of spin 1 exist they cannot survive the passage through the atmosphere.

The ordinary mesons (presumably of spin 0) are known to be beta-radioactive, and this has given rise to the suggestion that the ordinary beta-transformation, as observed in the nucleus, might be the result of a double transition in which, say, a neutron tends to transform into a proton plus a negative meson, the latter not being able to form in free space because the energy for its rest mass is not available and, therefore, transforming in turn into an electron plus a neutrino.

A quantitative study of this double transition shows, however, that the observed radioactivity of the meson is insufficient to account for the observed beta-decay constants by this double process. The suggestion has, therefore, been made that the latter is mostly due to the mesons of spin 1; there would then have to be ascribed to them a shorter life for beta-decay, which would satisfactorily account for their absence from cosmic ray observation.

There are, therefore, arguments for the existence of at least two kinds of mesons. In addition, the evidence from nuclei of light elements indicates strongly that the forces between like particles (two neutrons or two protons) is as strong as that between unlike particles, and this is hard to understand unless there exist neutral mesons as well as charged ones. Again, in all likelihood both values of spin, 0 and 1, would have to occur for each kind.

It is not settled whether the masses of mesons of spin 0 and 1 should be the same or different. Theories of the nuclear forces can be formulated with either hypothesis. There seems to be evidence from cosmic rays that not all observed mesons have the same mass. Whether it is possible to relate this difference of mass to the two spin values, or whether one has to assume independently two or more different masses for each spin and for both charged and uncharged mesons, is not as yet clear. In any event, one should not regard the meson as one fundamental particle but as a rather bewildering variety of them.

(8) *The negative proton.* For the same reasons for which Dirac's theory of the electron requires the existence of a positron, it is likely that there exists a counterpart of the proton with negative charge. This would annihilate any positive proton it collides with, and thus would not live long in the presence of ordinary matter. It cannot now be produced in the laboratory since this requires too much energy. There are reasons to think that it is contained in cosmic rays.

Lastly, it has been pointed out that, just as the wave equations of the electromagnetic field give rise to photons, and those of the nuclear force field to mesons, the gravitational field should be similarly quantized. Since gravitational forces are extremely weak if expressed in units appropriate to elementary particles, the quanta constituting the gravitational field would have only an extremely weak interaction with other particles. It is tempting to relate this to neutrinos, which are indeed extremely elusive particles; but the idea is somewhat less attractive when it is remembered that the symmetry properties of the gravitational field are such as would correspond to particles of spin 2, and that therefore the only way of introducing neutrinos would be in terms of an elementary process consisting of the simultaneous emission or absorption of four neutrinos. It is likely that this problem will remain in the realm of speculation for a considerable time.

SIXTH INTERNATIONAL CONGRESS FOR APPLIED MECHANICS

AT the Fifth International Congress for Applied Mechanics held in Cambridge, Mass., in 1938, an invitation to hold the Sixth Congress in Paris in 1942 was accepted. Though it was not possible to adhere to the original date, Prof. Henri Villat and his colleagues started to organise the Sixth Congress as soon as the war in Europe finished. Despite great economic and other difficulties, their courageous labours were completely successful, and the Congress was held in Paris at the Sorbonne during September 22–29. About 450 members attended, including scientific people from nearly all the Allied countries as well as from Switzerland, Italy, Denmark, Sweden, Turkey and Spain. The British group was large, and included many young scientific workers who have been attracted to applied mechanics in the course of their war activities.

The programme was a very heavy one, since it included the delivery of about two hundred and fifty scientific papers. These were divided among four sections, namely: (1) structures, elasticity and plasticity; (2) hydro- and aerodynamics and hydraulics; (3) dynamics of solid bodies, vibrations and sound, friction and lubrication; (4) thermodynamics, heat transfer and combustion.

So far as possible, the papers were grouped in symposia. In Section 1 there were symposia on plasticity, methods of calculation and impulsive loading; in Section 2 on turbulence, ship resistance, hydraulics, supersonic flow, aeroplane wing theory and instruments; in Section 3 on friction and lubrication; in Section 4 on jet propulsion and turbines.

Meetings of the four sections were held simultaneously, so that members who had interests in more than one section were not able to hear all they would have liked. A period of twenty minutes was allotted to each paper, including discussion on it. In this way, every author was able to get a hearing. In many cases, however, the time allowed for discussion was insufficient, and animated debates were carried on after the official closing time of the session.

The papers presented fell roughly into two groups, one comprising such normal developments of pre-war lines of thought as it has been possible to carry out during the war period. The other group consisted of papers stimulated by war activities, in some cases merely as a by-product of those activities. In the former group, the work of H. L. Dryden was specially noteworthy. At the time of the 1938 Congress, the way in which the boundary layer of retarded fluid close to the surface of a body changes its character from being in steady motion to being turbulent was the subject of much discussion and uncertainty. Dryden has now shown that if the air stream in a wind tunnel is sufficiently free from turbulence, an instability of the boundary layer which had been predicted mathematically does, in fact, appear at the calculated wind-speeds, and that it has the calculated frequency and wave-length. These unstable waves are masked by larger effects in wind tunnels not specially designed to be free of turbulence.

The second group contained a number of papers which had recently been released from war-time restrictions on publication. Some of these were devoted to the theory of high subsonic and supersonic airflow, subjects which have made great progress since the Congress of 1938. Others dealt with the analysis of stress waves in plastic materials, a subject which has now been brought forward for the first time.

The Congress was entertained at receptions in the Hôtel de Ville and the Inter-Allied Club. A large proportion of the members had the privilege of staying in the Cité Universitaire, a group of splendid hostels in which live many of the foreign students of Paris.

The science of applied mechanics owes a debt to Prof. Henri Villat and his colleagues for the initiative they took in organising so successfully such an important international scientific meeting so soon after the liberation of their country.

G. I. TAYLOR

EDUCATION IN THE BRITISH ARMY

By MAJOR-GENERAL CYRIL LLOYD, C.B.E., T.D.
Director of Army Education

I: Problems Involved

WHEN thinking of the Army Education Scheme it is not unnatural that the civilian mind tends to approach the problem by comparison with some civilian education organisation, for this is the only kind of yardstick ready to his hand. The soldier, on the other hand, will feel that he is a better judge; yet in the majority of present cases he will be able to bring to bear on the problem little more than the experience of some particular form of military organisation with which a few years' war service has made him familiar.

The Army Education Scheme was devised not as the best education scheme possible, but as the best education scheme possible in the particular circumstances in which the Army would find itself at the end of a long period of war. It follows, therefore, that if a true appreciation of the scheme is to be effected, the critic must first have a clear picture of the conditions in which the plan was designed to operate.

Assuming as we must that there must be some central body to plan, administer and co-ordinate, and that this body can only function successfully as part of the War Office organisation, it is of course obvious that control must pass downwards along the normal chain of military command through commanders-in-chief and successively through intermediate commanders to officers commanding the units in which the bulk of the work will be done. Here we find our first variable factor. In field commands the chain runs down through corps divisions and brigades · this seems simple enough until we realize that the modern division and brigade may vary in composition according to their operational role, and that outside this apparently simple chain there are corps troops, divisional troops, lines of communication troops and base installations which vary in composition and strength from one theatre to another.

General officers commanding-in-chief (home commands) operate through districts and sub-districts, and here it would not be untrue to state that in no case is the composition of any two districts alike.

In civilian circles the functional unit of organisation is the school : in the army it must be the military unit. As a basis of calculation for many purposes a unit is taken to be a lieutenant-colonel's command ; but in practice it may be anything from a handful of men in a camp reception station to a training centre fifteen hundred strong ; from a R.E.M.E. group scattered in detachments over a couple of counties to a compact battalion all under the hand of its commander ; from an A.T.S. company providing cooks, orderlies, clerks and typists for half a dozen separate headquarter offices to a small group of provost staff. "Somewhere in England" in 1942 there was a Petrol Can Recovery Unit with a strength of one officer and one other rank ; for months it claimed 100 per cent educational efficiency, for the officer was taking a correspondence course in law and the other rank was regularly attending the local technical school. They also closely followed the Army Bureau of Current Affairs. It will therefore be seen that the mere number of units in any given area is an indication neither of the volume of educational work in progress nor of the complexity of the organisational work it will entail.

The army educational authorities are faced with the task of providing instruction which will prepare the soldier to resume the responsibilities, the tasks, and the social duties of civil life, and this involves three main types of provision : current affairs and citizenship to prepare him for his civic responsibilities, pre-vocational training to help him to set a fair course for earning his living, and added to these two there must be that something more which will open up ways to greater and more satisfying enjoyment of his leisure hours. Current affairs and citizenship cause no insuperable difficulty, for they are common to all and can be carried out in groups in which the very variety of attainment may, and usually does, prove an asset. Education of the pre-vocational type and education in hobbies or cultural things lead us into two fields as unlimited in variety as they are boundless in scope. The illiterate and near illiterate provide at one end of the scale as difficult a problem as the advanced student does at the other, and between them are men and women at every stage of progress and intellectual development. Less likely are we to realize the infinite variety of the types of subject likely to be required until we have scanned the staggering range of trades and callings against the names in any company roll we may examine.

The estimate of library- and text-books required for effective working of the Army Education Scheme exceeded $2\frac{1}{4}$ million, to say nothing of handbooks for instructors and administrators which had to be compiled, edited and printed by the hundred thousand at a time when flying bombs were steadily taking toll of the already seriously diminished facilities. Nor were books the only acute problem : equipment of all sorts must be provided for practical work of all kinds. Tools for carpentry and metal work ; apparatus for the science students ; material for the dressmakers ; cooking and household kits for domestic science : these are but a few of the items which must be provided and provided quickly, not merely in Britain, but also at the end of long sea lines feeding all those foreign countries where British troops await their return home.

In Germany, Austria, Italy, Greece, Palestine, the Far East, troops have still heavy and arduous operational duties to perform. At home, too, young troops must be trained and hardened to replace those returning from overseas for release. Everywhere the work of servicing an army in being must go on.

It is against this background of reality that the commanding officer views the demand for six hours' education a week for every man and auxiliary, and it is small wonder that he raises his eyebrows. Let him contrive as best he may to release everyone at some time or another for six hours each week, and he is still faced with his education officer's complaint that with only one book-keeping instructor he is getting all the sixty book-keeping students at the same time, or that the six law students are separately available all on different days of the week. Let him satisfy the education officer in this respect and he may find that there is no driver for the ration van or that a working party is without N.C.O.s. If he is serving overseas he may have local climatic conditions against him—the summer noonday temperature in Baghdad touches 125° in the shade, India is little better, and in these parts of the world afternoon work is as impossible as early morning work is unpopular. Let him arrange all these things satisfactorily and he is still faced with the struggle to find suitable instructors and have them trained to fill the gaps caused by the ever-increasing demands of the release machine.

Surrounded by this sea of problems is the directing staff of the Army Educational Corps and A.T.S. officers and other ranks who are attached to formation staffs to advise commanders and administer the scheme under their direction. Theirs is the task to help commanding officers to surmount their difficulties, to arrange for co-operative effort between small units, to train replacement instructors, to keep the stream of books and equipment flowing freely. Here, too, we are faced with a fluid situation : education staff officers equally with others are released with their age and service groups, and unremitting effort alone can find and train suitable people to fill the gaps as they occur and deliver the bodies to that part of the world where their services are needed.

These, then, are some of the problems of those who planned and of those who are putting into effect what has been described as the greatest adult education scheme in history. Great as are the difficulties, the picture need by no means be a gloomy one. To see the facts as they are and at the right angle is necessary for a true appreciation, and those who find an interest in following this experiment will also find understanding of much that would otherwise puzzle and confuse them if they will remember that the plan was made to fit the army because, with its shape constantly changing and its size diminishing, the army could not be made to fit the plan.

Education as a part of military training is not something which has come into existence only with the citizen army of the Second World War. In the Regular Army before 1939 there was educational provision for all adult soldiers, which consisted of compulsory literacy for all rank and file, and a system of examinations (reaching approximately School Certificate standard), without passing which no man could be considered for promotion to non-commissioned officer or warrant officer. This provision was the responsibility of the Army Educational Corps.

During the first year of the War, the Army Educational Corps was extra-regimentally employed, and organised education in the Army was suspended The old peace-time system still remains in suspense, but in its place an even wider ranging system has developed, introduced to meet the needs of the period of hostilities and of the period when hostilities finally ceased. The historical development of this system may be briefly traced.

So early as December 1939, the Central Advisory Council for Adult Education in H.M. Forces, drawing its strength from a number of popular educational bodies, was instituted, and its framework of regional committees based on universities and university colleges was created. This organisation was destined to prove of great use to the Army in the years to come, as a source of civilian teachers and lecturers for classes and courses. In 1940, the next essential step was taken when a small directing staff was established at the War Office, and the Army Educational Corps was recalled to its educational role and given an increased establishment.

Until the autumn of 1941, education in the Army, drawing on the resources of the regional committees and administered by the Army Educational Corps at formation headquarters, was a voluntary affair in which men and women participated as inclination moved them and as opportunity offered. Lectures, gramophone circles, membership of local education authority evening classes, instruction in handicrafts were among the most prominent facilities; perhaps the most popular and successful service was the provision of a system of correspondence courses, at cheap rates, of which eventually tens of thousands were to avail themselves.

This voluntary system developed steadily throughout the War and has survived into the present period, though many of its activities are now conducted on a more formal basis under the auspices of the release scheme, which will be described later. Before the end of the War it had come to include provision for modern language teaching, play-reading, quiet rooms for reading and writing, debates, 'brains trusts', local study, and a variety of cultural activities. It was modified, where necessary, to meet the needs of hospitals and convalescent depots, or of illiterates whose first need was basic education, or of troopships, of detention barracks and military prisons, or of members of the A.T.S. It operated at home and abroad, though in the latter case the assistance of civilians was often lacking, and units had to rely far more upon their own resources than was the case at home.

In the last analysis, however, the voluntary system catered primarily for minority interests and affected only a minority of the troops serving. Moreover, it was in many ways more of a welfare than an educational provision, and in July 1941 education was linked with welfare in a joint directorate at the War Office, under the late Major-General Williams as director-general of welfare and education.

Since education on this scale was manifestly unequal to performing one of its major tasks, namely, that of sustaining morale and of improving efficiency throughout the Army, a separate and independent directorate, the Army Bureau of Current Affairs, was created at the same time.

From the late summer of 1941 onwards it became obligatory for units to set aside one hour of the weekly training programme for the discussion, under an officer's guidance, of current affairs. This marked an important development. An element of education was now compulsory, was regarded as part of training, and the instruction was supplied from the unit's own resources, instead of from the professional instructors of the Army Educational Corps or from outside civilian experts.

Army Bureau of Current Affairs did not immediately strike deep roots in the Army; officers capable of conducting discussion groups without some training in that art were few, and working units which had no training programmes often experienced difficulty in finding time for the weekly hour. But gradually the practice spread, and was powerfully reinforced a year later when, in November 1942, the British Way and Purpose was introduced as a system of formal instruction in domestic and foreign social and political studies. A weekly hour of B.W.P. was made compulsory in addition to A.B.C.A., and during the winter months of 1942–43 and 1943–44, 'winter programmes' of three hours compulsory education a week, of which two should be devoted to A.B.C.A. and B.W.P., were introduced. In many cases, B.W.P. proved a more successful undertaking than A.B.C.A. since, being more formally educational and only indirectly a morale-raising agent, instruction in it could be given not only by officers, but also by other ranks and civilians provided they were suitably qualified.

In summary, the war-time education scheme may be said to have had four aspects—personal or individual, military, civic and vocational. These reflected the four-fold objective of making the soldier or auxiliary a more enlightened individual, a better informed and more responsible citizen, a better soldier and a more capable bread-winner after returning to civilian life. Further, it was partly voluntary and partly compulsory—voluntary where individual tastes and interests were concerned, compulsory in matters of community interest which could be studied in common with fellow members of the community of the moment, that is, the unit or section of the unit. Finally, instruction was sought from the most convenient quarter in any particular case—from officers, non-commissioned officers or privates, whether of the Army Educational Corps or of the unit, and from a variety of civilian sources.

From the provision for these interests and the various methods of meeting them has grown the Army Education Scheme for the release period which is at present in operation. Planned during 1944–45 and operated by units as military conditions permit from within a few weeks of the end of the war with Germany, the Army Education Scheme represents the fruit of experience gathered during five years of war. In intention it is more ambitious than the war-time scheme was ; it enjoys a far more generous allocation of time, materials, accommodation and instructors ; in some directions the emphasis has shifted ; but fundamentally it is the war-time scheme writ large, and a brief account of it must now be given.

The foundation of the Army Education Scheme lies in the fact that it is compulsory ; within the framework of compulsion, however, there exists the greatest possible degree of variety.

The organisation of the Army Education Scheme is based upon the appropriate military formations or units. Army Educational Corps staff officers, concerned in administration of the scheme, are appointed down to brigade or sub-district level ; but the scheme is an Army scheme, not an Army Educational Corps scheme, and the normal unit of organisation is the lieutenant-colonel's command—say, about a thousand men or women. The scheme is, except for activities associated exclusively with one sex, co-educational.

Each unit implementing the scheme has its own library of four hundred books, its unit education officer, its own accommodation ; it supplies, so far as possible, its own instructors and, when these are not forthcoming, can borrow instructors from other units or from civilian resources. Materials, equipment and text-books are supplied on request, through normal Army channels.

The unit education staff is assisted in its tasks, not only by a series of handbooks covering organisation, libraries, equipment, materials, curricula and methods of instruction, as well as B.B.C. educational broadcasts, but also by the help and advice of the Army Educational Corps at higher formation levels. Districts conduct courses of training for unit instructors ; commands administer large lending libraries which supplement the resources of unit libraries, and are in a large measure responsible for the formation colleges. These formation colleges (three at home and two in commands overseas) offer vacancies for monthly residential courses of study in a number of faculties, and each has an instructor-training wing which trains unit instructors.

The degree of variety aimed at (as mentioned above) is faithfully reflected in the curriculum. Choice of subjects for study is restricted only in matters of community interest, and here two hours a week are compulsorily devoted to the political and social topics provided by A.B.C.A. and B.W.P. Otherwise the student may freely choose a course of study based on the graded syllabuses, which total more than a hundred and are grouped under six main heads : science, technical, domestic, humanities, commerce and professions, and art, crafts, music and drama. Every effort is made to encourage students to choose a balanced course of study—literary, manual, æsthetic—which will enable them to acquire new interests as well as to revive old ones. For the most advanced students who desire to sit for it, there is the Forces Preliminary Examination, of approximately matriculation standard, for which the Civil Service Commissioners provide the examining body.

The curriculum is wide and flexible enough to cater for those who require a general or a pre-vocational education. Those whose interests are best met by an element of vocational study can be catered for partly by the Army curriculum, and partly by additional facilities which are made available to provide them with the degree of specialized knowledge required.

II : The Army Education Scheme in the Field

Units in the field differ in respect of size, location and the work they do, and these differences undoubtedly affect the method by which, and the degree to which, they implement the Army Education Scheme.

These important factors had to be taken into account by the planners of the Army Education Scheme when they drew up a booklet of suggestions —the "Organization Handbook". At no time were the contents of this handbook considered as other than suggestions, as other than providing the framework within which units would adapt their own individual and peculiar circumstances.

In size, units may vary from a holding battalion, numbering up to five thousand men, to a salvage unit of twenty-five or an Army dental centre of three. The size of a large unit enables it to live fairly easily off its own resources. On the other hand, the size of a small unit will not necessarily mean a demand for a smaller number of subjects, but is very likely to mean a narrower choice of instructors.

In location, units may vary from the port operating company, working in a busy port, to the infantry battalion, policing a wide area of devastated Europe : from the anti-aircraft site in the hills to the Army pay office in the city. Location complicates the problem of the small unit. Normally, small units would either be grouped together to run a communal education scheme or attach themselves to a larger neighbouring unit, or take full advantage of near-at-hand civilian resources. The simple fact of isolation throws the small unit entirely upon its own resources, whereas the larger unit is relatively unaffected by these complications of location.

In work, the variety between units is even more clearly defined. The pay office and the record office are likely to be busier than they were at any time during the War. The same applies to other service and technical units, the duties of which continue in peace as in war. In contrasting the front-line operational units, it must be remembered that although much of their operational work may have ceased, they still find themselves helping the farmer, policing the town, or performing the many tasks the British Army is always expected to perform. In general terms, the large unit will have a considerable advantage over the small to the extent to which it can stagger duties. In a small unit, for example, the loss of one instructor and one group of men attending a class may in extreme cases take away 90 per cent of the unit strength and in other cases bring the work programme to a standstill.

In addition to the complication of size, location and work, all units have had to face certain common problems. Army accommodation was never specifically designed for educational activity and has had to be adapted in many ingenious ways. Nissen huts and tents have frequently been used for education as they have naturally been used for other purposes ; so too have gun operation rooms, motor transport workshops, etc. It should be remembered, too, that no new building was permitted for educational purposes. If a unit needed another hut it had to be collected from where it was no longer required and re-erected at the unit where it was needed

Equipment and books were initially in very short supply to the Army, as they were to the civilian world. Many units who during war had been accustomed to the speedy receipt of stores needed in battle found the initial delays of obtaining educational stores very irksome. In true Army fashion, many of them improvised; radio stores were turned over to the science room, pioneers' stores for the painting, decorating and woodwork classes; the blackout screens for the blackboard and woodwork; the sand table for the geography class. New equipment and books are now available in adequate quantities and nowhere are unit schemes impeded by shortage.

The problem which all units had to face was to leave a nucleus of instructors to run classes at the unit while others were trained in method and refreshed in matter at army schools of education, formation colleges, instructor training wings and courses run jointly by Army Educational Corps personnel and regional committees. Further difficulties have been caused by the incidence of releases, and keeping his instructors up to strength is a constant worry of every education officer. Some of them have come unskilled to teaching and have brought a freshness of outlook and originality of approach which many a trained teacher might envy.

The impact of the Army Education Scheme on a unit was naturally linked with the manner in which it was publicized to the man. The main publicity was in the hands of the unit officers, who had to explain in A.B.C.A. sessions the purpose of the Scheme. Its purpose requires somewhat subtle explanation to men and women, who will naturally judge the scheme by the use they get out of it, either as individuals, or in their work, or in their hobbies. Some units gave the aim of the Army Education Scheme as "fitting men and women for their return to civilian life". This is, of course, a perfectly proper statement of the bald aim of the scheme; but, unfortunately, some units interpreted this in a narrowly vocational manner. In many units, however, there have been outstanding examples of course-planning for individual men who thought in terms of practical trades being led to a balanced study of basic subjects which they could use in a wide variety of trades. Perhaps one of the best examples of this is the case of the men who wanted to do painting and decorating and whom the unit instructor required to calculate how much paint they required and cost a particular job (that is, elementary mathematics), order paint and equipment (that is, elementary English) and plan interior and exterior colour schemes and designs (that is, elementary art appreciation).

Units, large and small, are operating an Army Education Scheme which is broadly as outlined in the Organisation Handbook. For example, a holding battalion with an average strength of 1,800 men guarantees all of them a minimum of six hours education a week during the working day. Each day for five days a week 350 men attend unit classes. Eighteen courses are offered, ranging from home handyman, general education and commerce to plastering, bricklaying and woodwork. Each course is designed to last five complete weeks and is self-contained. All the instruction is given by twenty-one full-time unit education instructors and an approximately equal number of part-time instructors. A careful record has been maintained by the unit education officer of the age and service groups and consequently of the release dates of his instructional team, and he runs within the unit three-day courses for instructor replacements in order that he may assess the potential of his future education staff. In this manner continuity is maintained, and the smooth and effective running of the scheme is assured. The commanding officer has ensured that regimental officers regularly fulfil their duties as leaders of discussion groups, and each Friday afternoon the unit education officer holds a briefing meeting on the A B.C.A. topic for the following week. In addition, all men of the unit who are in the age and service group next due for release are given a further half-day weekly on education.

Essentially similar but on a smaller scale is an R.A.S.C. headquarters serving outside of Great Britain which numbers forty men. Each of these men receives his six hours education a week, and many have appreciably more. This small unit has thoroughly investigated its potential instructor material and finds that it is able with the help of local civilian and unit tradesmen to offer two kinds of courses, one consisting of world history, English language and literature, music and discussion groups, the other of leatherwork, art, motor engineering, market gardening and woodwork. It is the normal practice for each of the forty men to take part in all the first course and one or more subjects of the second.

The arrangements made in these two units are typical of many.

Another unit has its troops scattered over a relatively wide area and has decided that instead of moving the students to school they will move the school to the students. So the unit has formed a mobile team of instructors who can cover between them a range of cultural and practical subjects. These instructors set up school for a day wherever the troops are. In addition, the officers on the spot conduct A.B.C.A. sessions and have made a careful survey of any instructional talent they may have. Consequently it is rare for any small pocket not to be able to offer at least one subject as a supplement to those offered by the touring team.

In interesting contrast is the device of a coast regiment of the Royal Artillery which finds itself able to provide each of its men with twenty hours education a week. This regiment is disposed on three islands, and having decided that it was in a position to provide technical, commerce and general courses, obtained a statement from each man as to which course he wished to attend and turned each of its three islands into a 'faculty' so that 'technicians' were on one island, 'generals' on another and 'commercials' on the third; the instructional staff being similarly disposed. (The commanding officer was at pains to stress that no one island is better than the others.)

A collection of small units, including an ammunition supply depot, a company of Pioneers, the staff of an R.T.O., the staff of a reception centre and a company of R.A.S.C., solved their problem in another way. The largest of these units is the ammunition supply depot, which acts as the parent unit and accounts for all educational stores. Most of the other small units provide accommodation and an instructor for at least one class. In addition, out of their combined strength, the units manage to provide a full-time unit education officer who sees to the general organisation of the scheme. One full day a week is set aside for education, and all thirty of the instructors are part-time. On the educational day each week transport is arranged to collect the students, drop them at the unit where the classes are being held and return them at the end of the day.

It would be possible to multiply specific examples of different unit education schemes many hundreds of times. It is, however, important to recognize that there has been great variety of practice among units in implementing the Army Education Scheme both at home and abroad. It is certain that many troops will leave the Army without receiving their six hours a week education. It would be easy to lay the blame in many directions and in some cases it would be accurately laid ; but, by and large throughout the Army, there is tremendous good-will towards giving the men and women in the Forces what is, after all, nothing more than they have the right to expect—a chance to re-equip themselves for their return to civilian life ; and it is certain, too, that for many hundreds of thousands of men and women in many hundreds of ways, unit education schemes have shown a wider horizon and initiated the study of many subjects which will help the men and women in the years which lie ahead.

(*To be continued*)

OBITUARIES

Prof. P. F. Frankland, C.B.E., F.R.S.

We record with regret the death, at the age of eighty-eight, of Percy Faraday Frankland at his home in Argyllshire on October 28.

Born in London in 1858, he was the second son of Sir Edward Frankland, F.R.S., whose contributions to chemical theory and reactions, and whose pioneer work on the water supplies of Great Britain made him one of the outstanding scientific figures of his time. The son may be said to have followed directly in the footsteps of his father and to have attained a similar eminence. He was a pupil at University College School and at the Royal School of Mines, where he gained the Forbes Prize and won the Brackenburg Scholarship of St. Bartholomew's Hospital, at the same time graduating B.Sc. of London.

It was to the Royal School of Mines that Frankland returned in 1880 as demonstrator and lecturer in chemistry after an absence of some two years in the University of Würzburg, where he came under the influence of that great teacher, Wislicenus. The researches of Wislicenus on lactic and malic acids, and his subsequent development of the study of stereochemistry were stimulated by the work of Pasteur and by the publication in 1875 of van't Hoff's famous thesis : "La Chemie dans l'Espace". He had also followed up the work of Frankland and Duppa on acetoacetic ester and had used the zinc alkyls in his synthetic work.

While much of the early work of Wislicenus was influenced by the elder Frankland, it may be said that the son's interest in stereochemistry began while working with Wislicenus, under whom he graduated Ph.D. Little more than these relationships were needed to make Percy Faraday Frankland a life-long disciple of Pasteur. He was selected to give the Memorial Lecture on Pasteur to the Chemical Society in 1897.

The earliest researches of P. F. Frankland were on the illuminating power of burning hydrocarbons and the principles of combustion. He was, however, one of the first, after Pasteur, to study seriously the chemical reactions which occur by the agency of micro-organisms and to apply these processes in the production and isolation of pure substances. His popular book, "Our Secret Friends and Foes", was written from his expanded notes of the public lectures he gave to numerous popular audiences about 1893. Jointly with his wife, Grace, a daughter of Joseph Toynbee, F.R.S., whom he married in 1882, he published a life of Pasteur, and a volume on "Micro-organisms in Water". He continued his interest in this subject so long as he remained active, and his advice was frequently sought on the bacteriological purity of water supplies, in which field he was an acknowledged authority. The address he gave before the Society of Chemical Industry in February 1911 has long been regarded as an authoritative pronouncement on this problem.

Nevertheless, it may be said that Frankland's main contribution to the advancement of chemistry was made in the subject of stereochemistry, and his interest in this field never flagged. It was the theme also of many of his research pupils, whom he trained in the great school which he created at Birmingham. In recognition of his mastery as an investigator he was awarded the Davy Medal of the Royal Society in 1919, having been elected into the fellowship of the Society in 1891. Among his many research pupils were F. W. Aston, Thomas Turner, T. S. Price, R. C. Farmer, R. H. Pickard, T. S. Patterson, W. E. Garner, F. H. Garner, A. Slator, F. Barrow, S. R. Carter, and D. F. Twiss.

In 1888 Frankland was appointed to the chair of chemistry at University College, Dundee, and in 1894 he moved to Birmingham, where he succeeded Prof. W. A. Tilden in the chair of chemistry at Mason College. He continued to hold this chair in the University when it was founded in 1900, and the new University buildings at Edgbaston were built during this period. He was largely responsible for the design of the chemistry laboratories which his department occupied in 1909. Five years later he had to vacate them and return to Mason College to make room for the emergency military hospital which took over the buildings until the end of the First World War. During 1914–18 he was a member of the Admiralty Inventions Board and of the Chemical Warfare Committee, chairman of the Chemical Section of the Royal Society War Committee and of the Royal Society Reserved Occupations Committee. He took entire charge of tar-testing in the Midlands and advised on the production of explosives. In recognition of these services he was awarded the C.B.E. in 1920. He received honorary doctorates from the Universities of Birmingham, Dublin, St. Andrews and Sheffield ; also he was made an officer of the Italian Order of St. Maurice and St. Lazarus.

At the end of 1918 Frankland was confronted with the heavy problem of rehabilitating the Edgbaston laboratories after their occupancy by the military, and restarting his academic researches at the age of sixty. He felt this was a task for a younger man, and he resigned his chair and went to live in retirement at the House of Letterawe, Loch Awe, Argyllshire, where he could pursue his many interests amid surroundings which he loved. Here at the foot of Ben Cruachan his house looked out over the waters of the great loch with the panorama of mountains beyond. Here he indulged his wide interests in reading and in open-air life, and from here frequently set out on foreign travel with his wife, who had predeceased him only by a few weeks. He retained to the end his fine presence and vigorous manhood. His memory will long be cherished by his pupils, who recognized his commanding place as a teacher.

P. F. Frankland was elected president of the Institute of Chemistry in 1906, and of the Chemical Society in 1911. His two presidential addresses to the latter Society, in 1912 and 1913, on stereochemistry are still of vital interest and importance in this field of study. He leaves an only son, Edward Percy Frankland, who was for some time a lecturer in chemistry in the University of Birmingham.

W. N. HAWORTH

WE regret to announce the following deaths:

Prof. J. Shaw Bolton, emeritus professor of mental diseases, University of Leeds, on November 12, aged seventy-nine.

Dr. Dorothy Jordan Lloyd, since 1927 director of the British Leather Manufacturers' Research Association, on November 21, aged fifty-seven.

Mr. W. H. Roberts, recently city analyst at Liverpool and associate professor of public health chemistry in the University of Liverpool, on November 16, aged sixty-eight.

Mr. Charles Rodgers, O.B.E., deputy director of the British Electrical and Allied Manufacturers' Association and chairman in 1942–43 of the British Electrical and Allied Industries' Research Association, on November 5, aged seventy-one.

NEWS and VIEWS

Royal Society: Medal Awards

HIS MAJESTY THE KING has been graciously pleased to approve the recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows: Sir Lawrence Bragg, for his distinguished researches in the sciences of X-ray structure analysis and X-ray spectroscopy; Dr. C. D. Darlington, for his distinguished researches in cytology and genetics.

The following awards of medals have been made by the President and Council of the Royal Society: Copley Medal to Prof. E. D. Adrian, for his distinguished researches on the fundamental nature of nervous activity, and recently on the localization of certain nervous functions; Rumford Medal to Sir Alfred Egerton, for his leading part in the application of modern physical chemistry to many technological problems of pressing importance; Davy Medal to Prof. C. K. Ingold, for his distinguished work in applying physical methods to problems in organic chemistry; Darwin Medal to Sir D'Arcy Thompson, for his outstanding contributions to the development of biology; Sylvester Medal to Prof. G N. Watson, for his distinguished contributions to pure mathematics in the field of mathematical analysis, and in particular for his work on asymptotic expansion and on general transforms; Hughes Medal to Prof. J. T. Randall, for his distinguished researches into fluorescent materials and into the production of high-frequency electromagnetic radiation.

Special Election

UNDER the Statute of the Royal Society which provides for the election of persons who either have rendered conspicuous service to the cause of science or are such that their election would be of signal benefit to the Society, Dr. C. J. Mackenzie, president of the National Research Council of Canada, has been elected a fellow of the Society.

National Coal Board: Director-General of Research

DR. W. IDRIS JONES, in accepting the post of director-general of research for the National Coal Board, becomes the chief executive officer of Sir Charles Ellis, the scientific member. The Board is composed of functional members responsible respectively for production, marketing, labour, finance and scientific work. The scientific member's responsibility embraces problems ranging from day-to-day investigations connected with quality control to long-term research. Dr. W. Idris Jones, who is forty-six years of age, has wide scientific and technical experience to help him in this important appointment. He graduated at the University College of Wales, Aberystwyth. He was a Rhondda and Frank Smart research student of Gonville and Caius College, Cambridge, and took his Ph.D. (Cantab.) degree in 1925. After leaving Cambridge, he joined the research staff of Messrs. Synthetic Ammonia and Nitrates, Ltd. (later I.C.I. (F. and S.P.), Ltd.), at Billingham-on-Tees, and was later appointed a group manager in the Oil Division, where he was concerned with the development of the coal hydrogenation process. He was appointed director of research of the Powell Duffryn Co. in April 1933, an appointment which he has held until now.

One of the advantages of unified management of all the British coal mines is the opportunity it gives of tackling the major problems of the industry on a national scale. Dr. Idris Jones will find no lack of important objectives; on the contrary, in the early stages, the difficulty will be to arrange them in order of precedence. The problem of fuel preparation, whether in washing and grading, or in carbonization and briquetting, or in the degree of refinement of by-products, will doubtless have prominence. On the other hand, the problems of the human element, such as the whole study of working environment, as well as occupational diseases, will engage a large proportion of the Board's research interest. Dr. Idris Jones has an immense field before him; one that calls for the exercise of wise scientific judgment.

Mathematics at Leeds: Retirement of Prof. W. P. Milne

PROF. W. P. MILNE, head of the Mathematics Department of the University of Leeds since 1919, has retired and been appointed professor emeritus. After studying at the University of Aberdeen, where he obtained a doctorate, Milne took his mathematical degree at Cambridge as fourth wrangler, and received honourable mention in the Smith's Prize examination. He then became mathematics master at Clifton College, where he stayed until he was offered the chair of mathematics at Leeds. The appointment of a school master to a university chair was an interesting experiment, and there can be no doubt about its success. During his Clifton period, Milne wrote text-books on higher algebra, projective geometry, homogeneous co-ordinates and the calculus. But his greatest contribution to mathematics has been a number of papers, published mainly in the *Proceedings of the London Mathematical Society*, dealing with the properties of plane cubic, quartic and quintic curves, and the relations between the cubic surface and quartic curves, culminating in the properties and groupings of the 2,015 conics which touch the plane quintic curve at five distinct points. The University of Aberdeen recently conferred upon him the honorary degree of LL D.

Prof. Milne brought into the development of the Mathematics Department of the University of Leeds a profound knowledge of conditions in schools, and a deep appreciation of the need for the greatest width of knowledge combined with the mutual mental influence of different types of students sharing life in the same institution. He believed that research should be encouraged among all university mathematical students, and this has happened with some success at Leeds. He took a considerable share in the development of the University of Leeds as a whole, and during his period as pro-vice-chancellor he presided with great success over meetings of the Senate and other committees working out a scheme of post-war development. His influence in the County of Yorkshire was exercised through the Yorkshire Branch of the Mathematical Association which he founded in 1920, and through his work in connexion with the training colleges, when his Clifton experience was very valuable.

Geology at Liverpool: Prof. F. Coles Phillips

Dr. F. Coles Phillips, University lecturer in mineralogy and petrology at Cambridge, has been appointed to the George Herdman chair of geology at the University of Liverpool. Entering Cambridge from Plymouth College, he graduated in 1923, being placed in the first class in Part I of the Mathematical Tripos and in both parts of the Natural Sciences Tripos, with geology and mineralogy as his chief subjects. His first researches included investigations on the serpentines and associated rocks of the Shetlands: later, holding a research fellowship at Corpus Christi College, he was engaged in studies on progressive regional metamorphism in Cornwall and Scotland. Appointed demonstrator in mineralogy in 1928, he became University lecturer in the new Department of Mineralogy and Petrology in 1932.

More recently, Dr. Phillips has devoted his attention particularly to the field of ore microscopy, where he has developed equipment and technique for low-relief polishing of ores which have proved eminently satisfactory and have since been adopted in several research institutions at home and abroad. As an investigator in the field of structural petrology his work is well known, particularly his studies on the fabric of the Moine schists of the Scottish Highlands. These researches he is now extending into a general study of the significance of lineation in the crystalline schists of the North-West Highlands. As a teacher Dr. Phillips has been eminently successful, both in his contact with large undergraduate classes and in the post-graduate courses he has given in his special field of research. He served for many years as secretary of the Faculty Board of Geography and Geology and as member of a number of University committees connected with the work of the science faculties at Cambridge. The ripe experience in teaching, zeal for research and conspicuous organising ability which he will bring to the chair at Liverpool augur well for the future of geological studies at the University.

University of London: Appointments

The title of emeritus professor in the University of London has been conferred on Prof. C. L. Fortescue, recently professor of electrical engineering, Prof. C. H. Lander, recently professor of engineering, and Prof. E. F. Dalby Witchell, recently professor of mechanical engineering, at the Imperial College of Science and Technology.

The following appointments have been announced:

Dr. S. Tolansky, reader in physics in the University of Manchester, to the University chair of physics tenable at Royal Holloway College as from January 1, 1947.

Mr. A. J. Ayer, fellow and dean of Wadham College, Oxford, to the Grote chair of philosophy of mind and logic tenable at University College as from January 1, 1947.

Dr. John McMichael, formerly lecturer in human physiology in the University of Edinburgh and since 1936 Johnston and Lawrence Research Fellow of the Royal Society of Edinburgh and extra honorary assistant physician at the Royal Infirmary, Edinburgh, to the University chair of medicine tenable at the British Postgraduate Medical School.

Prof. G. C. Allen, since 1933 professor of economic science in the University of Liverpool, to the University chair of political economy tenable at University College as from April 1, 1947.

Dr. B. S. Platt, director of the Human Nutrition Research Unit of the Medical Research Council, to the University chair of human nutrition tenable at the London School of Hygiene and Tropical Medicine.

Dr. Kathleen Lonsdale, since 1945 Dewar Research Fellow at the Royal Institution, to the University readership in crystallography tenable at University College.

Dr. S. D. Elliott, since 1938 a Freedom Research Fellow in the Department of Bacteriology at the London Hospital Medical College, to the University readership in bacteriology tenable at the College.

The degree of D.Sc. has been conferred on Mr. Wilson Mandell, an external student.

Braunton Burrows

Braunton Burrows, on the north coast of Devon, a locality of unique characteristics and of great interest to the biologist and countryman, has been in use for military training during the War. This occupation seems likely to continue. In an article to *The Times* of November 2, a strong plea is made that this area should now be relinquished by the military authorities. For some two and a half centuries the Burrows have claimed the interest of men of science: the mobile dunes are of outstanding interest and provide materials not only for the plant and animal ecologist but also for the physicist, the geographer and the geologist. The flora, which is remarkably rich, includes species of rare occurrence.

It also affords materials for the study of adaptation to the extreme conditions presented by the wind-blown dunes. The fauna, not less attractive, contains among other things many local varieties and species of invertebrates. As the author states: "It is the whole complex of plant and animal populations and the special conditions in which they live that give this place such high scientific value both for urgently needed research and for education, and indeed make it unique in its kind".

Britain's Contribution to the War Effort

THE third and final report on Mutual Aid (Cmd. 6931. London: H.M. Stationery Office. 2*d*. net), with its record of mutual aid from July 1, 1944, to the termination of the various agreements, and with its statistical report of mutual aid throughout the War, has been published opportunely. It is fitting that this record of the magnitude of the assistance which Great Britain gave to the United States, the U.S.S.R. and other allies, as well as received, should be made public now that fresh demands are being made to avert a possible collapse of Western Germany. At the height of the War, the United Nations were aiding each other freely on the scale of about £4,500 millions a year, and over the three years up to the end of the War, mutual aid was extended by the United Kingdom to fourteen countries, and totalled £2,078,500,000. Excluding oil obtained under Lend-Lease, the value of supplies, services and capital received by the Allies amounted to 8 per cent of the national income of Great Britain and 16 per cent of her total war expenditure. The largest proportion of this—60 per cent—went to the United States, 15 per cent went to the U.S.S.R. and the remainder to European allies and China. The total value of reciprocal aid to the United States up to September 1, 1945, is estimated at £1,241,402,500, and of this total 26 per cent took the form of servicing U.S. Forces, 18 per cent is accounted for by the cost of building capital installations, the remainder being in respect of food, materials and equipment. More than half the services provided to American Forces is accounted for by shipping services.

In 1943, reciprocal aid was extended to include raw materials and foodstuffs, and from June 1943 until the end of the War, raw materials to the value of £31,351,000, two thirds of which was rubber, chiefly from Ceylon, were shipped from British Colonies to the United States on United Kingdom account. A total of 615,000 tons of bulk foodstuffs was also exported from the Colonies to the United States under reciprocal aid. Mutual aid to the U.S.S.R. totalled £318 million, of which motor transport (£118,856,000) and aircraft (£128,893,000) were the largest items. Mutual aid figures for other countries are less complete, but the estimated total of at least £519 millions includes £11 millions to China, £106 millions to France, £228 millions to Poland, £34 millions to Greece, £30 millions to Czechoslovakia, £24 millions to Belgium, £14 millions to Yugoslavia, and £32 millions to Turkey. These mutual aid arrangements have now ceased and trading is again on a cash basis. The vast flow of commodities and services exchanged and consumed in fighting the common enemy are not being left standing as monetary liabilities, but are being cancelled by common consent. This record of aid rendered by the United Kingdom provides a measure of an impressive aspect of her war effort which it is appropriate to recall at the present moment.

Health of University Students in Italy

THE substance of an address delivered by Marc Daniels at a conference held in Italy in connexion with the National Council of Research in 1945 has been published (*Ric. Sci. e Ricostruz.*, March–April 1946). He points out that university students are potentially the most precious possession of a nation, because they represent the intellectual and professional leaders of the future; but they are susceptible to various maladies during their period of study. It is remarkable that in the past so little care has been exercised on their behalf, not only in Italy but also in other countries. Daniels regards tuberculosis as the most serious problem confronting them because it is responsible for more deaths among the young people of both sexes than any other disease. During the War the mortality from tuberculosis increased considerably and in some parts of Italy was doubled, while in London it increased by 70 per cent among the young in the first year of the War. After tuberculosis, venereal disease assumed alarming proportions during the War in different countries, and there is no reason to think that Italy is an exception. A short description is given of the efforts that have been made to combat tuberculosis among students in the United States, Great Britain and France. The latter country has a special anti-tubercular service for university students, of which the author, who had first-hand knowledge of its working when it was initiated in 1932, speaks most highly. Although he does not think that in existing circumstances a national medical service in Italy is possible, he is convinced that every university in the country should regard the organisation of such a service for its students as lying within the limits of possibility. Medical attention at the beginning of a student's career and subsequent attention annually should form a chief part of the prophylactic services. Given a sufficient number of men of good will in the faculty of medicine, prepared to collaborate in the preparation of a medical programme, and given the co-operation of other faculties and also of students' organisations, the University of Rome should be able to institute a medical service for the students which would serve as a model for the assistance of the young people of Italy, on whom depends the future of the country.

A Welsh Folk Museum: St. Fagans Castle

A FULL description of the Earl of Plymouth's magnificent gift of St. Fagans Castle, together with 18 acres of land, to the National Museum of Wales appears in the *Museums Journal* of September. Following this gift (which was made this year) Lord Plymouth has arranged, "on very acceptable terms", the transfer to the Museum of an extra 80 acres of the park-land adjoining the gardens. This additional acquisition was essential in view of the development of St. Fagans as a folk museum. The establishment of a Welsh Folk Museum as an extension of the National Museum's services has been a long-felt need. In 1943 the Welsh Reconstruction Advisory Council provided an opportunity for publicly pressing the adoption of the proposal, and upon this the Museum Council submitted a recommendation that an open-air museum was an essential auxiliary to the National Museum of Wales. This recommendation was adopted by the Advisory Council, and now, in 1946, the scheme proposed materializes through the generosity of Lord Plymouth.

St. Fagans Castle dates from Norman times, and the present house, which was built within the thirteenth-century curtain wall of the fortress, is best described in the words of the report: "it is a dignified, picturesque and characteristic example of the commodious many-gabled style of Elizabethan times, containing lofty well-lighted rooms". The beautiful grounds, which will be maintained for the enjoyment of visitors, include terraced walks, formal gardens, fish-ponds and a treed hill slope. The extra 80 acres of park-land is reached through a short tunnel which runs beneath a fenced public footpath, and its higher parts overlook the Vale of Glamorgan. The policy for the Folk Museum envisages "as complete a picture of the Welsh past as possible, to create a 'Wales in miniature' where the visitor can wander in the confined area of a hundred acres through time and space, from the sixteenth century to the twentieth, from Anglesey to Monmouthshire, and see not only the old Welsh way of life but the variations in and the continuity of our culture". It will become "a centre for architectural and craft education, both visual and instructive". The house itself will be furnished in such a manner as to provide for the visitor a detailed study of the life and culture of the landed classes in Wales. The report, which contains three photographic reproductions of St. Fagans Castle with its gardens and park-lands, should be read by all those interested in the development of folk museums.

Manchester Libraries

Among points of interest in the annual report of the City of Manchester Libraries Committee for the year ended March 31, 1946, is the announcement of the impending reinstatement of the separate Technical Department in the Central Library in the room at present occupied by the Henry Watson Music Library, which will be moved to the second floor. Of the total 6,430,499 volumes issued during the year, 5,102,372 were from the home-reading adult and 819,533 from the junior libraries, and 508,594 from the reference libraries, which so far as issues are concerned have regained the ground lost during the War. Although 102,530 fewer volumes were issued than in the previous year, the average daily issue of 21,419 volumes was slightly higher. Grave concern is being caused by the continued heavy use of the already over-worked stock of the lending libraries, and the scarcity of copies of books in demand is so great that the libraries are compelled to circulate many thousands of copies which are, by pre-war standards, too shabby and dirty to justify a place on the shelves. In the reference section, where the absence of trained staff has been severely felt, the demand for library copies of prescribed books by university, college and school students is all the greater, because so many of them are out of print and unobtainable in any other way. It is embarrassing both to staff and students when some twenty students are anxious to use one copy of a set book. Again, while the total of 71,266 books added to the Libraries during the year, at an approximate cost of £20,700, is the smallest for many years, the average cost of each volume was almost three times the average before the War. The estimate for books has been increased to £30,000 for the current year, but of the 64,908 volumes withdrawn only 7,082 were replaced by new copies, due to the existing shortage of books. A feature of the year has been the increased use of the Commercial Library for all kinds of inquiries, and the value of the Information Bureau is well illustrated by examples quoted in the report.

Recent Earthquakes

During August 1946, seven distant earthquakes were recorded in New Zealand, and twenty-three were felt by persons in the Dominion. The greatest shocks had intensity 4 on the Modified Mercalli Scale, and occurred on August 1 and 12 near Lake Coleridge, on August 12 near Wanganui and on August 21 in the central parts of North Island. The United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association determined the epicentres of two shocks on August 28. The first, at 22 hr. 26·3 min. G.M.T., was an aftershock of the destructive Dominican Republic earthquake of August 4 off Samana Peninsula, and the second, at 22 hr. 28·2 min. G.M.T., occurred in Northern Chile.

During September, twenty-two earthquakes were registered at the Geophysical Observatory at Toledo in Spain, that on September 12 being in north-west Bengal, that on September 23 north of New Guinea and that on September 25 a further aftershock of the Dominican Republic earthquake (U.S. Coast and Geodetic Survey). In addition, there was an earthquake on September 18 not registered at Toledo. This happened in the Pacific Ocean off south-west Mexico (lat. 16° N., long. 101° W.).

On October 2 an earthquake had its epicentre south of Kamchatka (lat. 51° N., long. 157° E.), and on October 4 a further aftershock of the destructive Dominican Republic earthquake of August 4 occurred off the Samana Peninsula (U.S. Coast and Geodetic Survey). On October 19 an earth tremor shook Baghdad, but no damage is reported.

Lastly, on November 2, a violent earthquake took place in Central Asia. According to an official Moscow report, the earthquake was most strong in the district between Jalal-Abad in Khirghizia, and Fergana in Uzbekistan. This area is in the valley of the Syr Daria, where Uzbekistan's first steel works were built, and where there is an important hydro-electric station. A good deal of cotton is grown in the area, and this has been assisted by the construction of the Fergana Stalin Canal. The recent earthquake caused considerable material damage and loss of life, though the exact figures are not yet available.

Bibliography of Medicine

A Bibliographical Bulletin, covering medicine, veterinary science and pharmaceutical chemistry, published by the International Association of the Medical Press (71 Via M. Macchi, Milano, 300 lire; 2 dollars yearly), gives a classified list of books in these fields published in 1945 and 1946 or in preparation, the titles being arranged alphabetically by authors in each section. There is also an author index. The Association plans in 1946 to send such a bulletin free of charge to the editors of medical reviews, and it is intended that the second edition of this catalogue shall include a summary of information regarding all periodicals, whether discontinued or in course of publication. The editor invites the managers of medical reviews to forward all the necessary information regarding such publications. The Association is also negotiating with the authorities of the Vatican City for the use of the Vatican station for regular broadcasts of sufficient length to enable it to bring strictly scientific information from the medical press to the editors of medical reviews and to medical practitioners.

World List of Scientific Periodicals

ACTIVE preparations are being made for the issue of a third edition of the "World List of Scientific Periodicals". The second edition of this invaluable scientific reference work, issued in 1934 and covering the years 1900–33, is now out of print though still in constant demand. It contains upwards of 33,000 titles of journals and includes the holdings of some hundred and eighty libraries in Great Britain and Ireland. The new edition, which is designed to include all the scientific and technical periodicals that appeared during the period 1900–47 as well as the holdings of additional libraries, will, therefore, be considerably larger. Librarians are being asked to co-operate as before by sending particulars of all those journals on their shelves that do not appear in the second edition or are shown there as having no location in Great Britain, to the Secretary, World List of Scientific Periodicals, c/o Zoological Society of London, Regent's Park, London, N.W.8, from which office further information may be obtained.

"The Microtomist's Vademecum"

THE eleventh edition of "The Microtomist's Vademecum" is being prepared, and it is hoped that the new material will have been collected by early in the New Year. Laboratory workers are invited to submit accounts of methods which they believe should be included in the new edition to Prof. J. Brontë Gatenby, School of Zoology, Trinity College, Dublin; or to Prof. H. W. Beams, Department of Zoology, State University of Iowa, Iowa City, Iowa.

The Night Sky in December

FULL moon occurs on Dec. 8d. 17h. 52m., U.T., and new moon on Dec. 23d. 13h. 06m. The following conjunctions with the moon take place: Dec. 12d. 04h., Saturn 4° S.; Dec. 19d. 21h., Jupiter 1° S.; Dec. 20d. 02h., Venus 1° N.; Dec. 21d. 22h., Mercury 0·8° N. Mercury is a morning star, rising at 6h. on Dec. 1 and 7h. 20m. on Dec. 31, and attains its greatest westerly elongation on Dec. 9. Venus is conspicuous in the morning hours, rising at 5h. 54m., 4h. 50m. and 4h. 23m. at the beginning, middle and end of the month respectively. During this period its stellar magnitude varies between − 4 and − 4·3. The planet attains its greatest brilliance on Dec. 23 when its stellar magnitude is about − 4·4. Mars is too close to the sun for favourable observation throughout the month. Jupiter, a morning star, rises at 5h. 28m., 4h. 50m. and 4h. 05m. at the beginning, middle and end of the month respectively. The stellar magnitude of Jupiter remains nearly − 1·3 throughout December. Saturn can be seen during most of the night, rising at 20h. 28m., 19h. 30m. and 18h. 21m. on Dec. 1, 15 and 31 respectively. It is easily recognized as it is close to the star δ Cancri and cannot be mistaken for a star owing to the absence of twinkling. The following occultations of stars brighter than magnitude 6 take place in December: Dec. 1d. 18h. 36·0m., 69 Aqar. (*D*); Dec. 11d. 02h. 31·2m., 181 B.Gemi. (*R*); Dec. 11d. 04h. 13·6m., κ Gemi. (*D*); Dec. 11d. 05h. 14·3m., κ Gemi. (*R*); Dec. 13d. 23h. 27·7m., 46 Leon. (*R*). *D* and *R* refer to disappearance and reappearance respectively, and the latitude of Greenwich is assumed. Winter solstice is on Dec. 22d. 11h.

There will be a total eclipse of the moon on Dec. 8, visible at Greenwich. The circumstances of the eclipse are given below:

Moon enters penumbra	Dec 8d	15h	11 8m.
Moon enters umbra	8	16	10 2
Total eclipse begins	8	17	18 8
Middle of eclipse	8	17	48 0
Total eclipse ends	8	18	17 2
Moon leaves umbra	8	19	25 8
Moon leaves penumbra	8	20	24 2

Announcements

SIR ROBERT ROBINSON, president of the Royal Society, will deliver the Faraday Lecture of the Chemical Society on July 16, 1947, during the Society's centenary celebrations. The Faraday Lectureship was founded in 1867 to commemorate Michael Faraday. In normal times it is delivered every three years, and is the highest honour which the Chemical Society has in its power to offer. The list of names of previous Faraday Lecturers include Dumas, Cannizzaro, von Hofmann, Wurtz, Helmholtz, Mendeléeff, Lord Rayleigh, Ostwald, Fischer, Richards, Arrhenius, Millikan, Willstatter, Bohr, Debye and Rutherford. The Lecture will be delivered in the Central Hall, Westminster, and will form the principal scientific event of the Chemical Society's centenary celebrations.

DR. L. H. LAMPITT will deliver the second Sir William Jackson Pope Memorial Lecture before the Royal Society of Arts on December 4 at 5 p.m.; he will speak on Sir William Pope's influence on scientific organisation.

THE thirty-first Exhibition of Scientific Instruments and Apparatus arranged by the Physical Society is to be held in the Physics and Chemistry Departments of the Imperial College of Science and Technology and some adjoining galleries of the Science Museum, London; the provisional dates are April 9–12.

THE Radio Industry Council announces that Radiolympia—the National Radio Exhibition—will be resumed in 1947, the proposed dates being October 1–11. This exhibition will provide the first opportunity to display to the public and to the whole world the achievement of the radio industry of Great Britain in overcoming the many difficulties of reconversion to the design and production of radio, television, radar and electronic apparatus for civilian purposes.

THE wide scope of the work which has been undertaken by the British Electrical and Allied Industries Research Association is revealed by the contents of the annotated list of its published papers. This booklet, which is revised and published annually, gives abstracts of some five hundred reports covering the many aspects of electrical equipment and electricity supply, safety problems, insulating and magnetic materials, and electrical instruments and measurement.

BY a recent decision at the University of Cambridge, the professor of astrophysics is to be director of both the University Observatory and the Solar Physics Observatory. Prof. Harold Jeffreys, the newly appointed Plumian professor of astronomy and experimental philosophy, will thus not reside at the University Observatory.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Determination of the Electronic Charge by the Oil-Drop Method

A NEW determination of the electronic charge e is being carried out using a method which is a development of the photographic method previously used[1]. Instead of vertical plates and a horizontal field, horizontal plates are used as in Millikan's experiment. The present method has several advantages over the previous one. The path of the drop is now fifty or more times the distance measured, thus making the Brownian motion effect extremely small and enabling effects due to a change in charge of the drop or evaporation readily detectable if they exist. An accurate study of the electric field can be made, and by photographing much smaller droplets a check can be made of the presence of convection currents An interesting result has been obtained during the study of the field which may throw light on some of the previous oil-drop results, and so a brief report is made of this work.

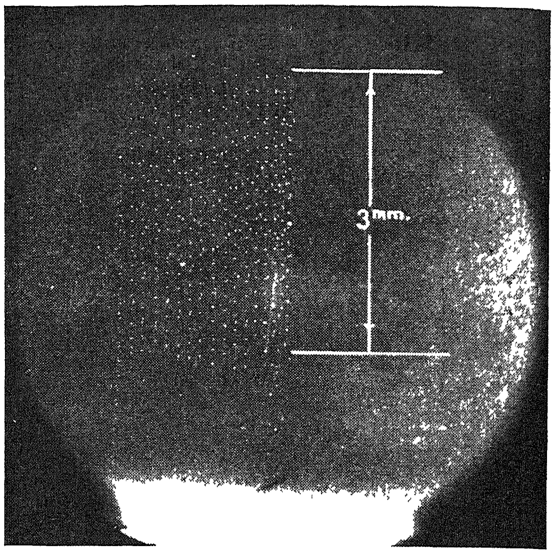

Fig 1

For the preliminary tests the condenser consisted of two circular steel plates, 3·7 cm. in diameter, optically polished and separated by glass pillars of length 0·6573 cm. In order to study the effect of the hole in the condenser plates on the field, a relatively large hole 1 mm. in radius was used, and as will be shown later a surprisingly large variation in field was produced by it. Oil drops after passing through this hole entered the field and were illuminated by flashes of light at intervals of 0·2 sec. either by using a rotating disk and projection lamp or by triggering a discharge tube. A concave mirror reflected the light so that the drops were illuminated almost equally in opposite directions. When a drop reached a lower part of the field, a potential difference of about 5,000 volts was applied across the plates; and if the drop was satisfactorily charged it rose towards the top plate. The plates were tilted at a small angle to the horizontal about the optic axis of a viewing telescope, and this enabled the rising drop to move to a slightly different part of the visual field. When the drop reached a certain height, the electric field was removed and the drop again fell under gravity, making a new track parallel to the first. This process was repeated until the drop passed out of the field of view. Two cameras facing in opposite directions allowed simultaneous exposures to be made of the one drop, and thus any error in magnification due to slight out-of-focus in one camera was compensated by the other. An arrangement has also been devised for moving the drop until it is sharply in focus before photographs are taken. The apparatus was temperature-controlled by a warm air method[2] which also controls the temperature of the room. Thorough air circulation was obtained by four fans, and all photographs were taken late at night with the room illuminated only by a sodium lamp. The apparatus was thermally shielded by an outside shield of thick copper, and the inner space lagged with cotton wool. The frequency of illumination and the voltage were controlled to 1 part in 40,000.

Measurements of the photographs showed that although the velocity of the drop when acted on by the gravitational field remained constant, the velocity of the drop when acted on by the combined electrical and gravitational fields varied along the path, the path being slightly curved, and also the average velocity along a path over a certain length varied over successive paths. This effect was studied over the whole field of view, and it was found to be due to the influence of the hole in the plate on the electric field. From the velocity of free fall and the velocity of the drop when acted on by both the gravitational and the electric field, the electric field at any point can be estimated. The average field for each path of ascent of the drop was calculated, and it was

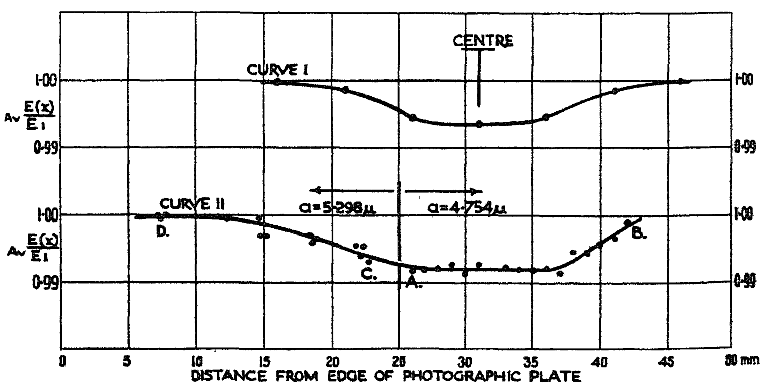

Fig 2

Curve I Calculated variation of average field for 1 mm radius hole in a plane 0 66 mm. from the axis of the hole. The average field was estimated over approximately the same length of path obtained in the photograph of the drops

Curve II. Observed variation of average field for the condenser used The lack of symmetry is due to the influence of the hole in the bottom plate, which was not directly below the top hole and the effect of which was not allowed for in drawing Curve I

From A to B, measurements from drop for which $a = 4\ 754\ \mu$
From C to D „ „ „ „ „ $a = 5{\cdot}298\ \mu$

x	$E(x)/E_1$	$E(x,R)/E_1$
0	0 500	
0 5	0 775	0 900
1 0	0 910	0 968
1 5	0 960	
2 0	0 980	0 987
2 5	0 988	
3 0	0 993	0 995
4 0	0 997	
5 0	0 999	0 999

found that this varied by 0·8 per cent over the field of view.

Calculations have been made on the effect of holes of various size on the electric field. The accompanying table gives figures for the ratio of the actual field $E(x)$ to the field, $E_1 = V/d$, at different heights in the condenser and at two distances from the axis of the hole. The first column gives the vertical distance below the top plate in terms of $x = z/R$, where z is the measured distance and R the radius of the hole. The second column indicates the variation in field below the centre of the hole, and the third column the field below the edge of the hole.

From a study of the spread of the drops which fell through the field of view when no field was applied, it was estimated that the focus of the camera was about 0·66 mm. behind the axis of the hole. Further calculations were made to obtain the variation in field in this focal plane. Curve I (Fig. 2) plots the average field over a central 3 mm. vertical path at distances 0, 1, 2 and 3 mm. to the right and left of the centre of the hole. Curve II shows the experimentally determined variations in field. The average field for each path of ascent of a drop was estimated and plotted against the position of the path on the plate. Two drops were studied, one of which ($a = 4{\cdot}754\,\mu$) moved to the right of the centre of the field and the other ($a = 5{\cdot}298\,\mu$) moved to the left of the centre, the tilt of the plates being altered between the taking of the two photographs. (More than seven hundred exposures were obtained of the drop which was deflected to the left.) There was a small hole in the lower plate to avoid the collection of oil on this plate, and as this was not directly below the top hole a slight lack of symmetry in the field resulted.

An attempt was made to check whether the influence of the hole would affect previous determinations of e by the oil-drop method. In order to avoid convection currents, Millikan[3] allowed drops to fall through five minute holes each $\frac{1}{4}$ mm. in diameter in the centre of the top plate, his plates being 14·9174 mm. apart and the distance of fall 10·220 mm. In this case the above correction for field variation would be negligible. Bäcklin and Flemberg[4] do not state the diameter of the hole; they used plates 0·3787 cm. apart and measured over a distance of fall of 0·25597 cm. Assuming that the closest distance of the drops to the hole was 0·614 mm., then for $E(x)/E_1$ to be less than 0·999 at this point, the hole would need to be less than 0·614/5 mm. or 0·123 mm. in radius. Had they used a hole 0·6 mm. in diameter, the correction to e would be 4 parts in 1,000 for drops falling in line with the centre of the hole, and this corresponds to the difference between their and Millikan's value of e. Hopper and Laby[1] used vertical plates, so no correction of this type would enter into their results. Errors, however, have been detected in this work, and those results will be discussed in a later paper in which full details of the present experiment will be given.

I wish to acknowledge the assistance of Mr. F. C. Barker in the theoretical calculations and Miss A. Grant in the experimental work. This work is being financed by a grant from the Council for Scientific and Industrial Research (Australia).

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Influence of Retardation on the London–van der Waals Forces

IN the course of his work on the stability of colloidal solutions, in which the attraction between the particles is ascribed exclusively to London – van der Waals forces, the repulsion being due to the interaction of electric double layers, Overbeek arrived at the conclusion that in order to account for the stability of suspensions of comparatively large particles, it is necessary to assume that for long distances the London – van der Waals energy decreases more rapidly than R^{-6}; and he pointed out that as soon as the distance becomes comparable to the wave-length corresponding to the excitation energies of the interacting atoms, the retardation of the electrostatic interaction between these atoms can no longer be neglected and will presumably lead to a decrease of the attractive force. Following Overbeek's suggestion, we have studied in detail the influence of retardation on the mutual attraction of two neutral atoms. As is well known, the usual expression for the London force is found by calculating the second order perturbation energy due to the interaction ·

$$\Delta V = \frac{(\vec{q}_1\vec{q}_2)}{R^3} - \frac{3(\vec{q}_1\vec{R})(\vec{q}_2\vec{R})}{R^5}, \quad . \quad . \quad (1)$$

where q_1 and q_2 are the operators of the total dipole moments of the two atoms. Since ΔV is proportional to e^2, the London interaction is proportional to e^4. In order to account for retardation effects, it is necessary also to consider the interaction with the radiation field, and since in this case the interaction operator is proportional to e, the perturbation method must be applied to the fourth order. Although several artifices are required to make the calculation feasible and to avoid divergences, the usual formulation of quantum electrodynamics leads to an unambiguous result.

The usual formula for the London energy between two neutral atoms in ${}^0S$ states is:

$$\Delta_2 E = -\frac{12\pi}{hcR^5}\sum_{l,m}\frac{q_l^2 q_m^2}{u_l + u_m}, \quad . \quad . \quad (2)$$

with $u_l = \dfrac{2\pi R}{hc}E_l$, where q_l is the matrix element of the total dipole moment between the S state and a P state with index l, and E_l is the energy difference between these states. The indices l and m denote the levels of the two atoms respectively.

When the influence of retardation is taken into account, formula (2) must be replaced by:

$$\Delta_4 E = -\frac{8}{hcR^5}\sum_{l,m} q_l^2 q_m^2 \int_0^\infty \frac{u_l u_m}{(u_l^2+y^2)(u_m^2+y^2)} (y^4+2y^3+5y^2+6y+3)e^{-2y}dy. \quad (3)$$

Each term of the summation in (3) converges to the corresponding term in (2), if:

$$R \ll \lambda_l = \frac{hc}{E_l} \text{ and } R \ll \lambda_m;$$

and therefore the London energy is proportional to R^{-6} if R is very small. In the case $R \gg \lambda_l$ and $R \gg \lambda_m$ the term in (3) is proportional to R^{-7} rather than to R^{-6}.

A simple illustration of essentially the same mechanism is obtained by studying the image force between one neutral atom and a perfectly conducting plane. In this case, the interaction energy is found to decrease as R^{-4} at large distances and as R^{-3} for $R \ll \lambda_l$.

Details of the quantum mechanical calculation and of the application of our results to the problems of colloid chemistry will be published in *Physica*.

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A Christiansen Filter for the Ultra-violet

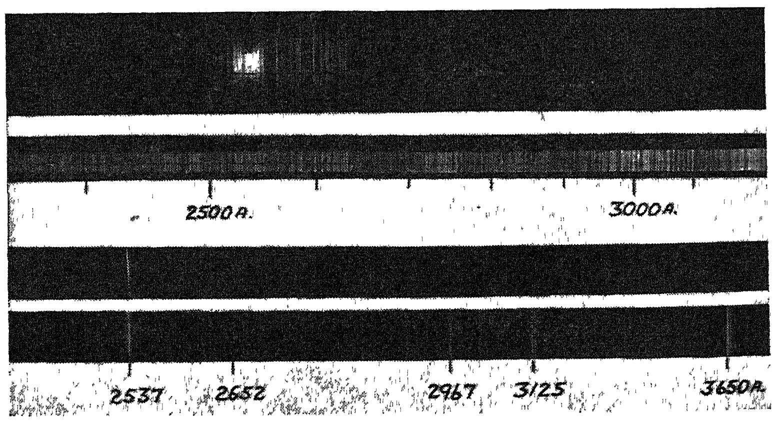
THE type of colour filter developed by Christiansen[1] consists of a powdered transparent solid (for example, glass) immersed in a liquid of about the same refractive index but with a different dispersion. For one particular wave-length the refractive index of the liquid and solid will be exactly the same, and this wave-length will be transmitted, while other wave-lengths for which the refractive indices are not quite the same will be scattered by the powder and so not transmitted. The theory of these filters has been discussed by Sethi[2], and Kohn and Fragstein[3] used a filter of amorphous silica in a mixture of 56 per cent benzene with 44 per cent ethanol to isolate the Hg line 3650 A. There does not appear to be any record of work farther in the ultra-violet, and it seems desirable briefly to report our attempts to develop a filter to transmit the 2537 A. line of Hg. This was required for quantitative measurements on the absorption of hydrogen peroxide produced during certain combustion processes.

Beyond 3000 A., the choice of suitable transparent solids and liquids is very limited. Attempts to make a filter using crushed fused quartz and mixtures of either chloroform, carbon tetrachloride, n-hexane, cyclohexane, or ethanol, were not very successful because the difference in the dispersions of the liquid and solid was insufficient. We obtained sufficient success, however, using crushed fluorite (CaF_2) in a mixture of carbon tetrachloride and ethanol. For 2537 A. we found that a cell (of fused quartz) about 0·75 cm. thick, packed with fluorite which had been sieved through a 60–120 mesh, and filled with a mixture of 43 per cent carbon tetrachloride with 57 per cent ethanol, was most satisfactory. The cell was heated in a water-bath at 18·6° ± 0·05° C.; a change of 1° C. altered the wave-length of maximum transmission about 10 A.

The cells were examined with an iron arc and a medium-size quartz spectrograph. To obtain good results it was essential to use the cell in accurately parallel light and not to place it too close to the slit. The testing set-up consisted of the arc, a quartz lens to render the light parallel, the cell, and a second lens to form an image of the arc on the slit; the lenses were focused for the ultra-violet. With this set-up the rays at the optimum wave-length formed a sharp image on the slit and gave a narrow spectrum in this region; wave-lengths slightly greater and less than the optimum gave a less well-defined image on the slit and hence a wider, less intense spectrum. The spectrum thus showed a cusp-shaped patch of light, as indicated in Fig. *a*, which may be compared with the normal arc spectrum without filter (Fig. *b*).

The filter gave a little scattered light of other wave-lengths, but the bulk of the transmission was limited to a narrow region about 50 A. broad. The transmission at the optimum wave-length was only about 1–2 per cent, but the filter did nevertheless isolate the Hg 2537 line fairly well, and it served our purpose satisfactorily. Figs. (*c*) and (*d*) show the spectrum of a quartz mercury discharge tube with and without the filter. With the mercury discharge tube no appreciable photochemical decomposition of carbon tetrachloride was detected, but with an iron arc some trouble was experienced, and it was necessary to protect the filter with another cell containing a thin layer of carbon tetrachloride which could be changed frequently. The tetrachloride used in the filter had to be carefully purified from unsaturated compounds which absorbed the near ultra-violet.

a
b
c
d



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Determination of Transverse Wave Velocities in Solids

A TECHNIQUE for finding longitudinal wave velocities in solids has already been described[1]; velocities of transverse waves can be determined with the same apparatus

Ultrasonic waves were generated by an oscillator connected to a quartz crystal. The waves were received by another similarly cut quartz crystal. The received waves were detected and measured by a two-stage radio-frequency amplification, followed by single stages of rectification and D.C. amplification. Screening of the detector set had to be thorough, so that it would not pick up any general electromagnetic radiation from the oscillator set. In this detail, the method for transverse waves differs from the method for longitudinal waves, where sufficient leakage of electromagnetic waves into the detector had purposely to be provided[1].

The crystals were placed flat upon solid surfaces, such as of concrete, marble, iron, copper, ebonite. Thin layers of glycerine were smeared on the surfaces for maintaining 'acoustic' continuity between quartz and the solid surfaces. A frequency of 300 Kc./sec. was used. As the oscillator crystal was moved away or towards the detector crystal (of course, either can be moved, whichever is practicable), the intensity of pick-up of ultrasonics was found to pass through maxima and minima. The distances between consecutive shifts for two maxima or two minima must be the half wave-length of the sound waves. Unfortunately, the programme of research had to be broken off at this stage, and no accurate measurements of the wave-length could be made; but the approximate measurements supported the theoretical expectation that the distances measured were half wave-lengths.

This technique has the advantages over the 'lycopodium powder' method of actually marking out the sound field by differential distribution of the powder by the sound on the solid surface, that only a very weak source of ultrasonics (fraction of a watt) is necessary, accurate measurements can be made of the shift of the movable crystal, the application of the method to field measurements for extended, immovable solids, etc.

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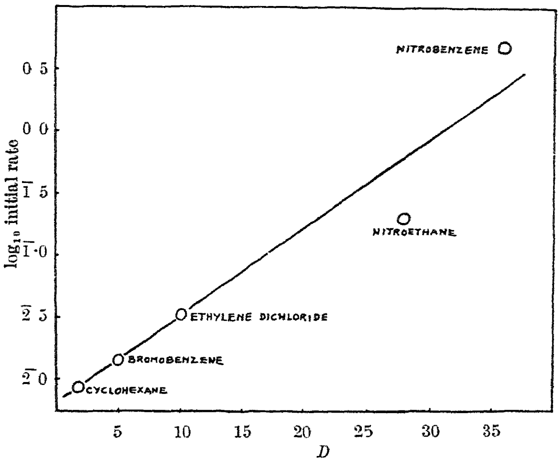
Friedel–Crafts Polymerizations

α-METHYLSTYRENE has been polymerized at 25° C., using stannic chloride as catalyst, both in solution and in undiluted monomer, giving polymers of molecular weight up to approximately 11,000. Staudinger[1], using this catalyst, obtained only a very low degree of polymerization (up to octamer), presumably due to the high temperatures reached in his experiments. The molecular weight of the polymer can be increased three-fold by polymerizing at 0° C., in agreement with the aluminium chloride-catalysed reaction[2].

The opinion is widely held[3,4,5] that polymerizations of this type (catalysed by acids, boron trifluoride, aluminium chloride, stannic chloride, etc.) proceed by an ionic chain process. Direct evidence of such a mechanism is provided by the observation that both the rate and degree of polymerization of α-methylstyrene are increased by increase in the dielectric constant of the solvent. Similar effects are well established in simple ionic reactions[6,7].



The accompanying graph shows a plot of $\log_{10}$ (initial rate) at 25° C. against dielectric constant (of the solvent) over a range from $D = 1\ 9$ (cyclohexane) to $D = 36$ (nitrobenzene), for an initial concentration of monomer of 1 36 moles/litre and catalyst of 9×10^{-4} moles/litre. (Rate = disappearance of monomer in moles/litre/min.$^{-1}$.) Over this range the molecular weight (number average) increases in a similar marked fashion, as shown in the table below.

Solvent	Dielectric constant	Molecular weight
Cyclohexane	1 9	500
Ethylene dichloride	10	1200
Nitro-ethane	28	(680)
Nitrobenzene	36	8500

There is, however, some quantitative uncertainty here, as it is difficult to remove traces of monomer from the polymer.

Until the effects of monomer and catalyst concentration have been fully determined, it will not be possible to deduce the formal kinetic steps. But if it may be assumed that these are the same in all the above solvents, and also that a stationary state is established, conclusions can be drawn about their nature. For a given monomer and catalyst concentration, the rate and degree of polymerization will depend upon the specific rate constants for initiation (k_i), propagation (k_p), and termination (k_t) as follows:

$$\text{Rate} \propto \frac{k_i\, k_p}{k_t};$$

$$\text{Degree of polymerization (number average)} \propto \frac{k_p}{k_t}.$$

The dielectric constant may, in principle, influence any or all of these rate constants, since all are likely to involve ionic processes. But the fact that both the rate and the degree of polymerization are similarly affected indicates that its main influence is on the ratio k_p/k_t rather than on k_i.

If the propagation step is the reaction of a monomer molecule with an ionic active centre, as generally assumed[4,5], then by analogy with simple reactions between neutral molecules and ions[7] we should expect k_p to be reduced by increase in dielectric constant. An increase in the ratio k_p/k_t can, therefore, only be secured by a similar but greater decrease in k_t. This will be the case if the termination process is the reaction of the positive ionic active centre with a negative charge as suggested by Polanyi[5]. (The rate of reaction between ions of opposite sign is reduced by increase in dielectric constant[7].)

Quantitatively, the equations developed by Eyring and his co-workers[7] for the reaction between two ions do not fit the above data. Perhaps, in view of the composite nature of the overall rate, this is not to be expected. Qualitatively, the results are in agreement with the theory that the dielectric nature of the medium acts mainly by influencing the termination rate, that is, the rate of destruction of ionic-growing chain centres.

No account has been taken of possible chain transfer processes, since they affect the degree of polymerization rather than the rate[8], and hence are unlikely to be important here. This is in marked contrast to the radical polymerization of styrene, where the influence of different solvents is attributed[8] entirely to their different transfer constants.

The polymerizations were followed, and the molecular weight of the products measured, by bromination. Full experimental details will be published later.

I am indebted to Dr. D D. Eley for helpful criticism of this note.

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Oct. 28.

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Cis-Trans Isomerism of Diethylstilbœstrol

Walton and Brownlee[1] have reported the conversion of pure ψ-diethylstilbœstrol (*cis* ?) into diethylstilbœstrol (*trans*) in 80 per cent yield by heating with alcoholic hydrochloric acid. Recent work in this laboratory has shown that heating with 2·5 *N* aqueous hydrochloric acid for periods of 30 min.–2 hr. converts both ψ-diethylstilbœstrol and diethylstilbœstrol into an equilibrium mixture in which, in so far as these two substances are concerned, diethylstilbœstrol preponderates in the ratio 9 : 1. The change has been followed by melting-point and colorimetric estimations[2] of the products isolated from saturated acid solutions after cooling to room temperature, and checked by comparison with the properties of suitable mechanical mixtures.

It would seem, however, that a simple binary equilibrium is not involved, and that at least one other—and presumably a more soluble and less chromogenic—substance is implicated. This may be deduced from the fact that the theoretical intensity of colour which might be expected from a 9 : 1 proportionality of the two substances is not attained in experiments involving quantitative recovery by ether extraction, and from the stability of the system over the period studied, which would seem to preclude any progressive change in the equilibrium conditions due to the gradual removal or destruction of one of the components.

The further possibility that the 9 : 1 proportionality in the solid phase may not reflect the true equilibrium ratio in the saturated liquid owing to differences in the solubilities of the *trans*- and ψ-forms, and that this ratio might be more nearly 1 : 1, which would very simply account for the low colour development, is not supported by preliminary experiments ; these show that both substances are only very slightly soluble in acid solution at room temperature and, in fact, suggest a slightly greater solubility for the *trans* form.

Œstrogen	Duration of acid treatment (min)	Product m pt °C (uncorr)	Product Chromogenic power*[C]	Recovery % theoretical chromogenic power [%C]
Diethylstilbœstrol	0	171	100	98
,,	30	157	94·5	79
,,	90	158·5	96	80
ψ-Diethylstilbœstrol	0	149·5	56·5	104
,,	30	157	96	75
,,	90	157·5	95	76
Mechanical mixture†	—	159·5	95	100

* Expressed as a percentage pure diethylstilbœstrol colour intensity.
† Diethylstilbœstrol : ψ-diethylstilbœstrol = 9 : 1.

Typical results are summarized in the accompanying table ; they are clearly of importance in the chemical estimation or biological assay of conjugated forms of diethylstilbœstrol after acid hydrolysis.

Hexœstrol has been found to be quite stable under similar conditions of acid treatment, and to yield quantitative recoveries.

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Metallo-organic Complexes in Soil

Dion and Mann[1] have shown that, as extractants for manganese from soil, neutral sodium and potassium pyrophosphates are much more effective than the corresponding orthophosphates. Since then, Heintze and Mann[2] have shown that various organic hydroxy-acids are almost as effective as pyrophosphate, and much more effective than the corresponding unsubstituted acids, as soil-manganese extractants.

From the start of this work it was obvious that there was a close parallel between the colour of an extract and its manganese content ; pyrophosphate, malate, citrate, etc., gave dark extracts rich in manganese, while orthophosphate, succinate, tricarballylate, etc., gave light-coloured extracts poor in manganese. The original observations of Dion and Mann[1] and Heintze[3] had already led Bremner and Lees (unpublished) to explore the possibility of using pyrophosphate as an extractant for soil organic matter (the nitrogen content of an extract was used as an index of its richness in organic matter), and, as these investigations showed that pyrophosphate was in fact a good organic-matter extractant, the new observations of Heintze and Mann prompted a similar investigation into the possibility of using malate, etc., for the same purpose. The results obtained showed that the hydroxy-acids were almost as effective as pyrophosphate, and the present joint investigation was therefore begun with the object of examining the possible correlation between the ability of an extractant to extract manganese, iron and copper from the soil, and its efficiency in dissolving soil organic matter.

The technique used was simple. One part of soil was shaken with five parts of neutral extractant intermittently during 24 hours. The extract was then filtered and its nitrogen content determined by micro-Kjeldahl, and its manganese, iron and copper contents colorimetrically by the usual methods—permanganate, dipyridyl and sodium diethyldithiocarbamate. The results given in the table are from experiments with a clay loam of medium organic nitrogen content, but comparable figures have been obtained from soils of different types.

AMOUNT OF ELEMENT EXTRACTED (μgm./gm SOIL)

Extractant	Copper	Manganese	Iron	Nitrogen
$M/5$ pyrophosphate	17	530	870	320
$M/5$ orthophosphate	3	trace	35	136
$M/5$ sodium citrate	6	520	397	360
$M/5$,, tricarballylate	—	trace	0	156
$M/5$,, malate	—	36	93	155
$M/5$,, succinate	—	trace	trace	70
$M/5$,, oxalate	7	trace	62	456
$M/5$,, tartrate	4	64	223	222
2 per cent sodium hydroxide	17	0	25	846

The results show that, on the whole, compounds that are good polyvalent-metal extractants are also good organic-matter extractants. Moreover, it is clear that these extractants are just those known to form co-ordination complexes with polyvalent metals. This suggests that some of the polyvalent metal in soil exists as an insoluble metallo-organic complex with some of the organic matter, and that, if the polyvalent metal can be removed from the complex by a suitable solvent (such as pyrophosphate), the organic matter becomes soluble. The metals in these metallo-organic complexes are not in the exchangeable form. Although a preliminary extraction of the soil with dilute hydrochloric acid removes the exchangeable manganese, iron and copper, such a pretreatment generally leads to an increase in the amount of nitrogen, manganese, iron and copper obtained in subsequent extractions by pyrophosphate, etc. The metal itself is usually extracted along with the organic matter, but that this is not necessarily so is shown by the oxalate result. It is true that 2 per cent sodium hydroxide gives an anomalous result, but there is already evidence (Bremner and Lees, unpublished) that the extracting power of sodium hydroxide may be due, at least in part, to a preliminary degradation of the high-molecular weight compounds initially present in the soil.

The metal-complex hypothesis is strengthened by our finding that when a pyrophosphate (or malate, etc.) extract is dialysed, the pyrophosphate and most of the metals are removed thereby, while the organic nitrogen which remains behind is water-soluble. The addition of manganese, copper or iron to this solution gives an immediate precipitate of the corresponding metallo-organic complex, which shows just the same type of solubility as is shown by the compounds originally present in the soil; it is far more soluble, for example, in pyrophosphate than in orthophosphate, and quite insoluble in water.

On the basis of these results we feel justified in advancing the theory that, in soil, part of the polyvalent metals is combined as co-ordination complexes with part of the organic matter, and that the presence of the metals renders the organic matter in the complexes insoluble in water, and in neutral solvents that do not themselves form complexes with the metals.

Full details of this work will be published later.

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Divalent Manganese in Soil Extracts

Dion and Mann[1] extracted trivalent manganese from soil with neutral solutions of sodium pyrophosphate. Such soil extracts gave a strong blue coloration with benzidine which was due to the trivalent manganese present. Later it was found that solutions of potassium pyrophosphate of pH 9 4 extracted significant amounts of manganese from soils. As the alkaline extracts gave no benzidine test, it seemed possible that the manganese present was in the divalent form. A number of soils representing different soil types were therefore extracted with $M/5$ pyrophosphate solutions at pH 7 0 and 9·4. Typical results are set out in Table 1, which also gives the exchangeable manganese determined by extracting the soils with N calcium nitrate, and the nitrogen content.

TABLE 1. NITROGEN CONTENT, EXCHANGEABLE MANGANESE AND MANGANESE EXTRACTED BY PYROPHOSPHATE SOLUTIONS AT pH 7 0 AND 9 4

Soil	Nitrogen mgm /gm soil	Manganese (p.p m)		
		Exchangeable manganese	Pyrophosphate soluble pH 7 0	pH 9 4
Barnfield 8·0	1 0	2	440	52
Barnfield 1 0	2 7	1	542	232
Swaffham	12·7	1	32	44
Wissington	26 0	14	49	128

The results indicate that one of the factors determining the fraction of the soil manganese extractable by alkaline pyrophosphate may be the organic matter content of the soil. Thus on a mineral soil of low organic matter content such as Barnfield 8·0, the manganese extracted with alkaline pyrophosphate is only a small fraction of that extracted by neutral pyrophosphate. On highly organic soils, such as the fen soils Swaffham and Wissington, the manganese extracted at pH 9·4 is higher than that extracted at pH 7·0. Similar results were obtained if solutions of the sodium salts of hydroxycarboxylic or polycarboxylic acids pH 7·0 or at pH 9·0 were used in place of pyrophosphate. The alkaline extracts gave a negative test with benzidine; Heintze and Mann[2] used solutions of such reagents at pH 7·0 for the extraction of manganic manganese from soils.

Evidence to prove that manganese extracted by alkaline pyrophosphate solution from soils is present in the manganous state was furnished by developing an observation by Lingane and Karplus[3]. It was possible to show that divalent manganese in pyrophosphate solution can be estimated by addition of excess manganese dioxide followed by estimation of the amount of trivalent manganese in solution. The reaction proceeds according to the equation $MnO + MnO_2 = Mn_2O_3$. Conditions under which this reaction takes place quantitatively have been worked out. At

pH 7·0, the reaction reaches completion in a few minutes with hydrated manganese dioxide, in 24 hours with commercial manganese dioxide. It does not take place at pH 9·4

Some results of applying this method to alkaline pyrophosphate extracts of mineral soils are set out in Table 2.

TABLE 2 REACTION BETWEEN PYROPHOSPHATE EXTRACTS OF SOILS AND MANGANESE DIOXIDE (COMMERCIAL)

Soil	Manganese (p p m) Original extract	After treatment with manganese dioxide
Barnfield S 0	52	120
Barnfield 1 0	256	580
Clay loam high in organic matter	464	1200

In the case of mineral soils with low or only moderate organic matter content, the soluble manganese found after reaction with excess commercial manganese dioxide was slightly more than double the amount initially present in the pyrophosphate extracts. The filtrates showed by their benzidine reaction test that the manganese was present in the manganic form. If, however, hydrated manganese dioxide was used, the reaction went further than doubling the manganese content. Soils with high organic matter content gave high increases in soluble manganese with both commercial and hydrated manganese dioxide. These results suggested that the organic matter in the extracts may also reduce manganese dioxide. If the pyrophosphate extracts were dialysed to separate the manganese from the bulk of the organic matter, the dialysates reacted with manganese dioxide to give trivalent manganese in amounts much nearer the theoretical doubling of their manganese contents.

It may, therefore, be concluded that the manganese found in alkaline pyrophosphate extracts of soils is in the manganous form. It may exist in the soil in the form of co-ordination complexes with the soil organic matter in accordance with the theory put forward by Bremner *et al.*[4]. On the available evidence, however, the possibility of its formation by reduction during the extraction cannot be excluded. Manganese deficiency occurs typically on soils of high organic matter content, and it would appear possible that in these deficient soils the conditions may be such that all the divalent manganese is fixed by the organic matter in a form unavailable to the plant. Its presence in the extracts makes it necessary to reconsider whether the trivalent manganese found by Dion and Mann[1] in neutral pyrophosphate extracts occurs as such in soils, or whether the reaction $MnO + MnO_2 = Mn_2O_3$ takes place in the pyrophosphate extractant. The reaction between divalent manganese in pyrophosphate solution and manganese dioxide may be of a general nature and applicable to some of the other so-called transition elements. The occurrence of such reactions and their possible significance in soils are under investigation. Full details of the work will be published later.

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Effect on Rats of Purified Diets with Synthetic B Vitamins

DURING the early years of the War, we investigated the possibility of providing the factors of the vitamin B complex in growing rats by giving them these factors exclusively in the form of the following synthetic components thiamine, riboflavin, pyridoxine, niacin, pantothenic acid and choline. Most of our unpublished results have been confirmed by other investigators, and may be found in the Anglo-American literature of 1940–45. Some of our experiments, however, are in essential details different from those already reported.

After weaning for three weeks, young male rats of an average weight of 31 gm. were kept on one of the following diets.

Diet A. Yellow maize 40 per cent, wheat 30 per cent, milk powder 15 per cent, casein 1 per cent, dried baker's yeast 7 per cent, cotton seed oil 2 per cent, arachis oil 2 per cent, cod liver oil 2 per cent, calcium carbonate 0·5 per cent, sodium chloride 0·42 per cent, iron ammonium citrate 0 08 per cent.

Diet B. Recrystallized sucrose 74 per cent, vitamin-free casein 18 per cent, cotton seed oil 2 per cent, cod liver oil 2 per cent, adequate salt mixture 4 per cent. Per kgm. ration were added . 2 mgm. thiamine hydrochloride, 2·5 mgm. riboflavin, 3 mgm. pyridoxine hydrochloride, 10 mgm. sodium pantothenate, 300 mgm. nicotinic acid, and 300 mgm. choline hydrochloride.

Diet C. As diet B, containing the same amount of synthetic B vitamins, but with the addition of 50 gm. dried brewer's yeast per kgm. ration.

Diet A has been used by us for several years for breeding our stock rats. It proved to be a highly satisfactory ration for normal development.

The experimental diets B and C were given during the second week of weaning to those mothers whose litters would receive it exclusively a week later on during the experiment. In this way we prevented storage of unknown factors in the young animals.

Young males only were used for the increase in weight comparison. For each diet we used a group of seven animals; their mean weight is given in Table 1.

TABLE 1

Diet group	Average weight (gm.) of the rats at the age of 21 days	28 days	40 days	54 days	61 days
A	31	52	103	171	198
B	31	49	94	155	177
C	31	53	113	189	211

Though growth on diet B is slower than in the others, the animals showed no signs of any deficiency. An average growth of $3\frac{1}{2}$ gm. a day over such a long period may be considered as really favourable.

The full-grown males on diet B, without changing their diet, were paired with seven females brought up on the same purified diet B. All seven females produced normal litters, varying from four to nine, and totalling 52 animals. 34 of them (65 per cent) died during weaning. Three females lost their whole litters, and only one litter of seven animals remained fully intact. The resulting 18 animals, which after four weeks weaning had reached the average weight of only 28 gm., were at that time separated from their mothers, and divided in two groups. One group was still given diet B, the other received diet C. This second generation grew astonishingly well, as may be seen from Table 2.

TABLE 2

Diet group	Average weight (gm.) of the rats of the second generation aged: 28 days	40 days	54 days	68 days	82 days	96 days	105 days
B	28	60	106	146	177	194	208
C	28	70	128	180	201	208	214

As in the first generation, growth on diet C is faster than on diet B The animals on diet C were mostly advanced in weight at ten weeks of age. They then weighed 180 gm., that is, 30 gm. more than the animals on diet B. But later on this difference diminished again, until it was of no significance at 15 weeks of age.

Simultaneously with the experiments reported above, we investigated the influence of brewer's yeast on the regeneration of blood. For these experiments we used twelve young male rats, which after a normal weaning period of three weeks were divided in two equal groups, receiving respectively diets B and C. After five weeks they had all reached a body-weight of 150–200 gm. They were then bled at intervals by heart puncture under light ether anæsthesia. After each puncture 2 c.c. salt solution was given intraperitoneally and the animals were well warmed until normal movements were regained. All animals were handled ten times in the course of 26 days, and a total of about 23·5 c.c. blood per animal was taken during that period. The total amount of blood is about 8 per cent of a rat's body weight, so that within four weeks one and a half to twice the total blood volume of the animals was taken.

Regular erythrocyte counts and hæmoglobin determinations were done in a drop of blood taken from the tail. The frequent heart punctures resulted in a decrease in hæmoglobin and the number of erythrocytes. No pathological changes in the red or white blood cells were observed. The erythrocytes were in general more basophilic than normal, and some normoblasts were seen. These are indications of active blood regeneration.

Complete regeneration to normal values for hæmoglobin and erythrocyte numbers in both groups was observed within fourteen days after the last puncture. Quantitatively there was a difference between the two groups. But it is not necessary to assume that there is an essential dietary factor for blood formation present in brewer's yeast, the complete recovery in Group B being as fast as in Group C. There was, however, a difference in body-weight between the animals of the two groups (these may be compared with the data given for the gain in weight), and therefore some difference in blood volume may be responsible for the quantitative difference observed

Fouts *et al.*[1] found total nitrogen in blood lowered in dogs kept on synthetic diets Total nitrogen was also determined in the blood of both our groups B and C, immediately after the last heart puncture No difference was found between them, total nitrogen being on the average 35·3 mgm and 34·5 mgm. per c.c. blood.

Similar experiments have been published by Kornberg *et al.*[2], who succeeded in producing anæmia only in the presence of sulphasuxidine in the diet. By using older rats bled by heart puncture, we produced anæmia without the use of a sulpha-drug. The rapid regeneration in our animals gives a good impression of the power of the bacterial synthesis of folic acid in the gut.

Summarizing the results obtained, we conclude:

(1) Normal growth and maturation of rats can be maintained during at least two generations on a simple, purified diet with vitamin B supplied by six synthetic components (B_1, B_2, B_6, niacin, pantothenic acid and choline), and a normal final weight is reached in a normal time.

(2) This growth is slower than on the same diet supplemented with 5 per cent brewer's yeast, but there are no indications that growth is suboptimal.

(3) Blood regeneration on the purified diet is as fast and as complete as in that of 5 per cent brewer's yeast.

(4) Reproduction on the purified diet is normal, but during the weaning period physiology seems to be unfavourably influenced; perhaps some specific factor essential for lactation fails in the purified diet.

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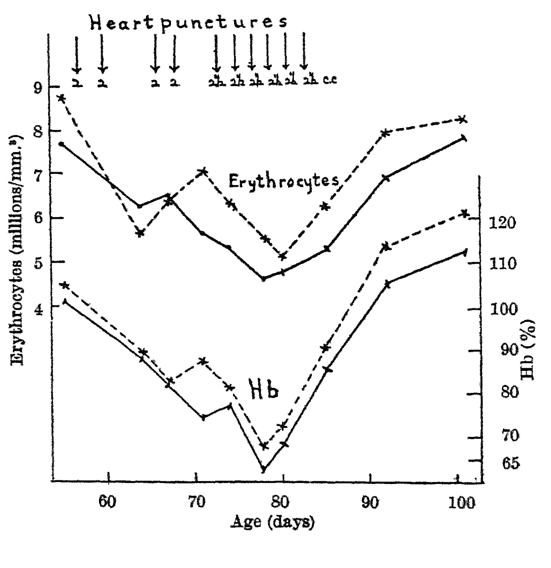
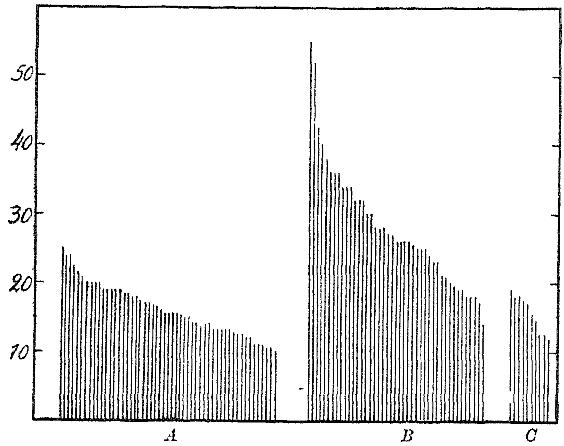


Disturbances in Oxidative Metabolism in Choline Deficiency

THE common symptoms in rats on a choline-deficient diet are, as is well known, fatty liver, impeded growth, and in young animals renal hæmorrhages (for references see Best[1]). There has been discussion as to whether the vitamin character of choline is due only to its content of labile methyl groups, or if the lipotropic action has a more specific mechanism. The experiments reported below show that an impairment of oxidative metabolism is an early symptom in choline deficiency.

Young albino rats on an inbred stock, 28 days old and weighing 24–26 gm., were placed on a diet practically choline-free consisting of 40 per cent suet, 40 per cent sugar, 15 per cent purified casein, 5 per cent mineral mixture, and sufficient amounts of vitamins A, D and E, thiamine, lactoflavine, nicotinic acid, pantothenic acid, and menadiolsodium diphosphate. Controls had the same diet with the addition of 0·6 per cent choline chloride. The body weight was



TIME IN MINUTES REQUIRED FOR DECOLORIZATION OF METHYLENE BLUE *in vacuo*

A, controls, *B*, choline-deficient rats, *C*, choline-deficient rats which had been given 1 mgm choline chloride intramuscularly 60 minutes before being killed. Every line represents the mean of two values from the same rat Each Thunberg tube contained 1 250 γ methylene blue, dissolved in 2 5 ml *M*/15 phosphate buffer *p*H 7 15, and 0 2 gm of minced muscle of hind limbs

determined every day. Every second day, four controls and four 'choline-free' rats were killed and examined for liver fat, blood sugar, bilirubin, non-protein nitrogen, and prothrombin index. The oxygen consumption of the minced muscles of the hind limbs was measured in Warburg respirometers.

In accordance with Griffith and Wade[2] and others, we found renal hæmorrhages on the seventh to ninth day followed by uræmia. At this point there was, as a rule—but not always—a slight increase in liver fat but no increased bilirubin values. Earlier, deposition of fat in the liver was observed, and two to four days before the occurrence of renal hæmorrhages the impeded growth, quite obvious on the fourth day, suggested a disturbance of a more general kind.

Considering the mechanism of action of the better known members of the B vitamins, for example, thiamine, lactoflavine and nicotinic acid, we studied the oxidative metabolism of minced muscles of the hind limbs. In choline-deficient animals oxygen consumption decreased to about two thirds of the normal values. In twenty-five animals on the test diet plus choline the oxygen consumption of 1 gm. of muscle pulp in 60 minutes was found to be $56 \cdot 4 \pm 1 \cdot 5$ mm.^{3}; in twenty-one rats on choline-deficient diet the corresponding value was $37 \cdot 1 \pm 1 \cdot 3$ mm.^{3}. The impairment of the metabolism occurred earlier than renal hæmorrhages.

The decrease in oxygen uptake corresponds to a slower decolorization of methylene blue *in vacuo* (see graph). Addition of choline in physiological concentrations to the minced muscles *in vitro* is not sufficient to normalize the metabolism. Experiments with addition of *d*-*l*-methionine *in vitro* have hitherto not given positive results, in spite of the prominent role of this amino-acid in transmethylation. The specificity of the impairment of the oxidative metabolism as a symptom of choline deficiency is, however, shown by the pharmacological effect of choline. If 1 mgm. of choline chloride is injected intra-muscularly only 60 minutes before the choline-deficient animal is used for experiment, the ability of its muscles to decolorize methylene blue is normal.

These experiments suggest that choline, or at least its methyl groups, are essential for intermediary metabolism, probably by being used in the formation of an unknown co-enzyme.

Detailed reports are to be published in *Acta Pharmacologica et Toxicologica*.

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Aggregation of Red Blood Cells in a Strong Electric Field

ERYTHROCYTES, when suspended in blood plasma, form 'rouleaux', in which the single erythrocytes lie parallel like a pile of coins This phenomenon is dependent on the presence of a specific substance in the plasma. When suspended in an isotonic sugar solution, the erythrocytes settle to the bottom very slowly, without forming any characteristically shaped aggregation. On the other hand, the same suspension of blood cells, when exposed to the influence of a powerful electric field (approximately 100 V./cm), rapidly forms macroscopically visible aggregations of red blood cells, quickly settling to the bottom. In this way, all erythrocytes are separated from the supernatant sugar solution in a few minutes.

The following interpretation of this surprising phenomenon is suggested The erythrocytes contain a solution of different electrolytes (for example, KCl, K–Hb, etc.) and are, therefore, conductors. When suspended in a solution of a non-electrolyte, they form a dispersion of small conductors in a non-conducting medium. In a strong electric field these small conductors become oriented by electric induction. The erythrocytes become dipoles, the opposite poles of which attract each other, and form chain-like aggregates. In accordance with Stokes's law, sedimentation-rates of such red-cell aggregates will be greater than those of single non-polarized blood cells.

Experimental. Human citrated blood is centrifuged, the plasma decanted, and the erythrocytes twice washed with an isotonic sucrose solution. Then the erythrocytes are suspended in isotonic sucrose solution. The suspension is poured into a U-tube (length about 10 cm., diameter about 0·5 cm.). The suspension in both limbs is covered with an isotonic solution of glucose, which has a much smaller specific gravity than the isotonic sucrose solution. Metal electrodes are dipped in the glucose solution in both limbs of the U-tube, and 500–1,000 V. imposed on the electrodes. After approximately a minute, the red cells have formed clots, which rapidly sink to the bottom of the tube. When the current is stopped, the sedimented erythrocytes can be easily dispersed again by shaking. The electric aggregation of blood cells is, therefore, reversible, and in this respect analogous to the reversible coagulation of some colloids.

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Fermentation of Wood-dust by Cellulose Bacteria

In this laboratory, fermentation of birch, aspen and pine-dusts has been investigated by enrichment cultures of thermophilic[1], and recently also of mesophilic[2], cellulose bacteria. he Tfiner the wood was ground, the more of the cellulose was fermented In the best cases, a fermentation of about 70 per cent of cellulose in wood was obtained with the leaf-tree dust at 60° C. Distinct fermentation could be noted only a day after inoculation. Our results have thus disproved the earlier conception that the cellulose in wood is fermented only when lignin is in some way destroyed[3], and are evidence against the supposition that cellulose and lignin are chemically bound in wood. Nevertheless there may be such a linkage, for the long cellulose molecules may be broken on grinding wood. If we presume that lignin is bound to the other end of the fibrous cellulose molecule, there would be formed from the free end of these molecules fragments which afford a suitable substrate for bacteria. As lignin is decomposed to some extent during fermentation (in one experiment with birch dust the decrease in the lignin content was 11·4 per cent, and in methoxyl content 29 2 per cent) the bonds between lignin and cellulose can also be broken, so that even the cellulose bound with lignin becomes fermentable. The assumption that a part of the cellulose in wood is bound with lignin, while a part is free, is in accord with our findings. This would also explain why the whole amount of the carbohydrates in wood-dust could not be fermented.

One of our observations made in connexion with cellulose fermentation deserves particular attention. The volume of gas first formed in the thermophilic fermentation decreased during further fermentation, if the gas trapped in the burette was in contact with the fermentation flask. Thus at the end of fermentation there might be found less carbon dioxide than was liberated from calcium carbonate by acids formed in fermentation. In such cases the gas mixture contained no hydrogen. In fermentation experiments where some carbon dioxide was developed, hydrogen was also formed in some measure. These findings and the great amount of acetic acid formed in fermentation showed that carbon dioxide is used for synthesis during fermentation. Presumably acetic acid is thereby formed, according to the equation: $4H_2 + 2CO_2 = CH_3.COOH + 2H_2O$. Wieringa[4] has noted such a reaction with *Clostridium aceticum.*

Also with mesophilic cellulose bacteria (enrichment cultures from the rumen of sheep) Koistinen[2] has recently noted an active synthesis of acetic acid from the gases formed in the fermentation of wood-dust. When carbon dioxide was added to the system, acetic acid was formed corresponding to 130 per cent of the fermented holocellulose, while carbon dioxide was simultaneously consumed. In this case the reaction seems to have proceeded primarily according to the equation: $CH_4 + CO_2 = CH_3COOH$. The reaction may also occur partly through the reduction of carbon dioxide caused by hydrogen, as has been assumed in connexion with the thermophilic fermentation. The combination of carbon dioxide has been noted only in an acid reaction (pH 6·0–6·5).

The building up of fatty acids in cellulose fermentation through the reduction of carbon dioxide suggests new views of the activity of the rumen. The large amount of carbonates which goes in saliva to the rumen may be used up for the synthesis of fatty acids. The amount of gas formed in the rumen may, in turn, essentially depend on this synthesis, which, again, is determined by conditions in the rumen.

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Symbiosis of *Azotobacter* with Insects

In 1912, I published (*Ber. d. bot. Ges.*) a preliminary note on the constant symbiosis of Aphides with *Azotobacter*. The entomologist, Prof. K. Šulc, of Brno, had previously (1910) found that the hitherto mysterious function of an organ in aphides and similar insects, called the pseudovitellus, was a seat of symbiotic organisms. I succeeded in isolating and identifying them as belonging to the genus *Azotobacter*, and in 1916 published the results of my studies in the Prague *Zemedelsky Archiv.*

Owing to difficult and unfavourable circumstances it was not possible for me to devote much further attention to the subject until recently, when I discovered that the organisms in the mycetocysts or mycetomes (pseudovitellus) procure for the insects free nitrogen from the air for the synthesis of proteins that are primarily necessary for producing the enormous quantity of eggs and young. I have now also found instances of *Azotobacter* symbiosis in *Lecanium Persicæ, Limothrips* (which absorb sugars from plants in the same way as aphides, cycades, etc.), in the larvæ of the beetle *Anobium paniceum*, in the imago of the grain beetle *Sitophilus*, in the larvæ of the moth *Sitotroga cerealella*, and in the larvæ of the 'bark-boring' beetle *Eccoptogaster rugulosus*. These insects would starve for lack of nitrogenous food were it not for mycetome symbiosis with *Azotobacter*.

I have concentrated my attention on the disastrous epidemic now raging in the spruce forests of Czechoslovakia, caused by the bark-boring beetle *Ips* (*Bostrychus*) *Typographus* L. This epidemic is a result of the ruinous economy practised during the German occupation. The beetle multiplied in the borderlands where the felled tree trunks supplied plenty of food, and from these trunks infection spread to healthy trees.

Possessing no laboratory (my Institute at the Agricultural and Forestry School was plundered by the Germans), I confined myself to microscopical examinations. The eggs and very young larvæ were found to contain large numbers of the *Azotobacter*. In this respect *Ips* resembles aphides. The method consisted in crushing and smearing material from the organs, fixing with a flame, removing fat with xylol, alcohol, water and blue cotton, and then mounting in Canada balsam.

Longitudinal sections through a young larva of *Eccoptogaster* revealed large masses of intact *Azotobacter* zooglœæ in the peripheral layers of the tissue, whereas in the digestive organ of the same larva a mass of *Azotobacter* was being digested, with the result that older larvæ were enriched with fat and other substances Similar observations were made with the larvæ of *Ips* (microtome sections). In 1942–44, L. Tóth and others (*Z. vergleich. Physiologie*) proved by micro-Kjeldahl determinations that preparations from twenty different species of the order Rhynchota (aphides, *Aphrophora*, *Philœmus*, *Cassidœ*, some *Lygœidœ*, etc., as well as those from *Pyrrhocoris apterus*) considerably increased their nitrogen content in a very short time. Insects with well-developed mycetomes (aphides, Homoptera) fixed free nitrogen much more energetically than the Heteroptera, which are devoid of them.

Aphides, Homoptera and Heteroptera are thus able to assimilate free nitrogen. Bark-boring and other beetles and the moth investigated have to be included in this group. This remarkable insect-symbiosis corresponds in magnitude with that in Leguminosæ. I have named these symbiosis bacteria *Azotobacter Sulci* sp. n. Details will be published shortly.

JAROSLAV PEKLO

Phytopathological Institute,
Praha XII.
Oct. 21.

Hypocupræmia in Cattle

THE occurrence of a suspected copper deficiency in cattle in Aberdeenshire was recently reported[1], the evidence being based on the low copper content of the pastures and on the similarity of the symptoms to those of 'peat scours' in New Zealand described by Cunningham[2]. No blood copper data were given to correlate the suspected low copper status of the cattle with the low copper value of the pasture.

In a recent investigation by Bythell[3] of a severe chronic scouring disorder among a small herd of cattle in Cheshire, the following blood data were obtained in this Laboratory, the only abnormality observed being the low copper values.

TABLE 1. BLOOD ANALYSES OF AFFECTED CATTLE

Animal Ref. No.	Cu mgm./ 100 ml.	Hb gm / 100 ml	Ca mgm / 100 ml serum	Mg mgm / 100 ml. serum	Acetone mgm./100 ml serum
1	0·02	11 2	10 8	2 6	<3
2	0 03	10 2	9 6	2 3	<3
3	0 03	9 7	10 2	2 2	<3
4	0 02	10 4	10 2	2 4	<3
6	0 01	11·2	10 7	2 4	<3
8	0 03	11·1	10·3	2 5	<3

Normal copper values for adult bovines have been reported by Bennetts *et al.*[4] to range from 0·07 to 0·17 mgm. per cent, and Cunningham[5] gives the average normal value as 0·09 mgm. per cent. These are similar to our round value of 0·1 mgm. per cent obtained from numerous analyses at Weybridge. It will be noted that the values tabulated above are from one third to one tenth normal.

In appearance, the fields grazed by the affected animals resembled a peat bog, and because of this and the chronic scouring, the disease was thought to be similar to the 'peat scours' of New Zealand. Analysis of the pastures, however, showed normal copper contents of more than 10 p.p.m. The data on three fields are as follows (Table 2), lead, molybdenum and fluorine values being included for reasons which need not be elaborated here. Cattle scoured on fields I and II but not on field III.

TABLE 2. ANALYSIS OF PASTURES (DRY MATTER BASIS)

Field No	Cu p p m	Pb p p m	Mo p p m	F p p m
I	11 0	7 9	9 0	9 9
II	12 3	5 4	6 9	9 7
III	25 8	6 1	5 1	3 2

The disorder, therefore, differs in two respects from New Zealand 'peat scours' and the suspected copper-deficiency disorder in Aberdeenshire, both of which were associated with low copper values of the pastures and with low hæmoglobin values in the affected animals. The hæmoglobin levels in the cases reported here all fall within the normal range[6]. The blood picture resembles that of ewes in areas in Derbyshire where 'swayback' in lambs is prevalent[7], and where the ewes appear clinically normal and show no scouring. In the corresponding areas of 'enzootic ataxia' in Australia, low copper values are shown both in the pastures and in the blood of the ewes. In Derbyshire, blood copper values are low but pasture values normal.

While these cases were under investigation, blood samples were received from Blakemore[8] from cattle suspected of suffering from a copper deficiency in the Fen country. Blood copper values in seven animals ranged from 0 03 to 0·08 mgm. per cent, the average being 0 047 mgm. per cent. Pasture analyses showed normal values of 8–16 p.p.m copper (dry matter basis), although a sample of hay was so low as 4 7 p.p.m. Clinical symptoms included stunted growth, rough coats and depressed appetite, but diarrhœa was observed only in later stages.

These two cases from widely separate areas and different soil types seem to represent the first records of bovine hypocupræmia in Britain.

RUTH ALLCROFT

Veterinary Laboratory,
Ministry of Agriculture and Fisheries,
Weybridge. Oct. 31.

1 Jamieson, S., and Russell, F. C., *Nature*, **157**, 22 (1946)
2 Cunningham, I. J., *New Zealand J Agric.*, **69**, 559 (1944).
3 Bythell, D. W. P., personal communication
4 Bennetts, H. W., Beck, A. B , Harley, R., and Evans, S T., *Austral. Vet J.*, **17**, 85 (1941).
5 Cunningham, I J., *New Zealand J. Sci. and Tech*, Section A, **27**, 381 (1946).
6 Allcroft, W. M , *J. Agric Sci.*, **31**, 320 (1941).
7 Eden, A., Hunter, A. H , and Green, H. H., *J. Comp Path and Therap.*, **55**, 29 (1945)
8 Blakemore, F., personal communication.

The Course of the Controversy on Freedom in Science

OUR attention has been directed to the passages in our recent article on this subject[1] in which we stated that the British Association (among other bodies) "began to support and even to take part in the new propaganda", and that at the meeting of its Division for the Social and International Relations of Science in September 1941, "no one was allowed to speak during the three days of the Conference except those previously chosen by the organisers, and the movement against pure science and freedom in science had free play". We gladly accept the assurance that the speakers were not selected by the Council of the Association because they held the doctrines we oppose, and that the reason why other speakers were unable to take part in the discussion was that all the time available was occupied by the speakers chosen. The Council no doubt believed that all the chosen speakers could make useful contributions to the subject of the Conference. But the result, we think, was very unfortunate. Naturally, we welcomed the entirely different atmosphere of the British Association's Conference on Scientific Research and Industrial Planning in December 1945, at which there was freedom for anyone to speak. The views that dominated the 1941 meeting no longer dominated that of 1945. On controversial as on all other matters which vitally affect the welfare of science, the British Association should provide an open forum, and we are glad to believe that this is its constant aim.

JOHN R. BAKER

University Museum,
Oxford.

A. G. TANSLEY

Grantchester, Cambridge.

[1] *Nature*, 158, 574 (1946)

Research and the Smaller Firm in Britain

IN *Nature* of November 2, p. 638, an account was given of the recent conference held in Manchester under the auspices of the Manchester Joint Research Council. This article gives a misleading account of my paper.

The references to the Mellon and Battelle Institutes give the impression that I am opposed to the operating principle of these institutes in all circumstances. What I did in my paper, after giving as impartial a survey as I could of the advantages and disadvantages of their methods of operation, was to give reasons why I doubted if a "Mellon Institute" is the solution in Great Britain to-day of the problem of research and the small firm. The fact quoted in the article that ". . . the Mellon Institute is largely supported by the large firms" rather than by small ones was in fact used by me in support of my argument.

The most serious misrepresentation occurs at the end of the first paragraph: "Dr. Toy's paper indicated concern as to the future of the research association in Great Britain and its ability to win the confidence of the industry it served". This question of confidence was not directly under discussion in my paper, but I may state here quite categorically that I feel no such concern: and I am not aware of any such indication in my paper.

On the specific point of *confidential* research for the smaller firm, I gave reasons why I thought the idea of doing research confidential to one firm in the research association's laboratories, *using research association personnel*, did not seem to be a really workable scheme. It clashes with the primary principle of the research association movement that research should mainly be on an industry-wide basis, and for the benefit of the industry as a whole; and it also involves the danger that the research man might find himself in the impossible position of having to carry out confidential research for a firm, and general research for the industry on the same or related subject. I said I doubted if a firm could do better than carry out confidential research on its own, and that even a small firm could do something worth while if it had the right outlook and the right man. I was also at pains to show that the problem of research and the small firm was made much easier nowadays due to the existence of the research associations, with their unequalled knowledge of the industry and its problems. In particular, two illustrations of this were given. A firm wishing to set up a research department of its own could call on the research association for help and advice on such matters as staff, equipment, etc. Alternatively, a firm not yet prepared to go so far as to set up its own research department might, I thought, be accommodated at the research association, which would supply material facilities, such as space, equipment, library and so on; supplying, in fact, many if not all the advantages of the "Mellon" system, except the staff, which in my view should be in the employment of the firm.

At the end of the article, when summarizing what Sir Edward Appleton said, occurs the following sentence: "When facilities and staff are available, the Department of Scientific and Industrial Research will be prepared to assist a small firm by arranging to carry out special investigations into specific problems, although it is not possible to offer the same facilities as the Mellon Institute or the Battelle Institute—a statement which appears to conflict with Dr. Toy's remark that the research associations themselves are not encouraged to undertake work at cost for an individual firm". The "conflict" between the two statements is more apparent than real. The hesitancy of the research associations to undertake confidential work is due to the danger to which I have already referred. This danger—quite acute in a research association limited to a single industry—would be much less and possibly non-existent in a central government laboratory operating in a much wider field, though even in this case Sir Edward did not promise "the same facilities as the Mellon Institute".

Thus there is no conflict of ideas in the suggestion that the Mellon principle, while not really workable in a research association, might *in principle* be quite feasible in a central government laboratory. Whether this is desirable is quite another matter. My own view is that the smaller firms would not make any more use of a Mellon Institute in Great Britain than they do in the United States.

F. C. TOY

Shirley Institute,
Manchester.
Nov. 11.

The Thyroid and Tuberculosis

THE results quoted by Izzo and Cicardo in their communication[1] on this subject are of great interest to us as we have had somewhat similar animal experiments under way for some time.

Izzo and Ricardo seem, however, to have misread my letter, as they state that Burger and his associates found diploicin to possess tuberculostatic activity *in vitro*. It was clearly stated by me[2] that diploicin is insoluble, and accordingly was not subjected to *in vitro* tests. The substances tested were prepared by opening the depside ring, thus solubilizing the diploicin molecule. These substances were prepared in this laboratory and tested by my colleague, Dr. P. A. McNally, in Trinity College, Dublin.

VINCENT C. BARRY

Department of Chemistry,
University College,
Dublin.
Oct. 28.

[1] Izzo and Cicardo, *Nature*, 158, 590 (1946).
[2] Barry, *Nature*, 153, 131 (1946).

USE OF SMALL-SIZE PLOTS IN SAMPLE SURVEYS FOR CROP YIELDS

By Prof. P. C. MAHALANOBIS, F.R.S.

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OWING to absence abroad, I had missed Dr. P. V. Sukhatme's note discussing this subject[1]. The over-estimation of crop yields with sample-cuts of a very small size was reported by us in 1940, and since then a good deal of work on the subject has been done in the Indian Statistical Institute. Certain observations based on the experience gained in the course of the above work would appear to be called for in the present connexion.

The principle of random sampling in crop-cutting work was explicitly recognized for the first time by J. Hubback[2] in his experiments on paddy in Bihar and Orissa in India during 1923–24 and 1925–26 in which the size of the sample-cut was 12 5 sq. ft. or 1/3,200 acre. Following him, C. D. Deshmukh during 1928–29 and 1930–31 and P. S Rau in 1928–29 and 1929–30 used the same size of sample-cuts in their work on paddy in the Central Provinces, of which I have recently given a brief account elsewhere[3]. Hubback's work had also influenced that of R. A. Fisher, who used sample-cuts of a small size in his work on wheat at Rothamsted[4]. H. P. V. Townend in his work on paddy in Bengal in 1938 had also used small cuts of 27·04 sq. ft.

When we first started crop-cutting work on jute in Bengal in 1939, we had collected some data for sample-cuts of five sizes ranging between 25 sq. ft. and 66 sq. ft. There was some evidence of bias, but the available material was meagre. Next year we therefore thought it advisable to investigate whether the results in any way depended on the size of cuts; and in work on jute in 1940 we used sample-cuts of various sizes ranging from 1 sq. ft. (1/43,560 acre) to 256 sq. ft. (1/170 acre approximately), and detected unmistakable evidence of over-estimation in cuts of a very small size. The results were given in considerable detail in "The Statistical Report on Crop Estimating Experiments on Jute in Bengal, 1940", which was printed for official use but was not issued to the public under war-time restrictions. The vice-chairman of the Imperial Council of Agricultural Research in India (the organisation in which Dr. Sukhatme has been working as statistician for a long time) is the *ex-officio* chairman of the Indian Central Jute Committee which financed our work and which printed my report; but I do not know whether Dr. Sukhatme has seen a copy or not of this report. I had, however, explicitly referred to the size bias in my paper, "On Large Scale Sample Surveys"[5], and had stated: "In crop-cutting work on jute it was found, for example, that mean values for all characters studied (such as number of green plants, weight of green plants, weight of dry fibre) were much higher for sample units of small size, so that it was not at all safe to work with cuts of a size less than say 25 sq. ft.".

Dr. Sukhatme has not referred to the above observation.

In explanation of the observed over-estimation with small-size cuts, Dr. Sukhatme writes: "The reason for over-estimation appears to be the human tendency to include border plants inside the plot. This factor becomes serious when the perimeter of the plot is large in proportion to its area." In the paper "On Large Scale Sample Surveys"[5] I wrote: "It was found that there was persistent over-estimation in working with units of very small size. In the case of field survey the obvious explanation is that the investigator has a tendency to include rather than to exclude plants or land which stand near the boundary line or perimeter of the grid. This boundary effect naturally becomes less and less important as the size of the grid is increased." Hence Dr. Sukhatme's explanation is identical with that put forward by me four years ago.

I must confess, however, that my own opinion has changed a good deal in the light of further work which has been done by the Indian Statistical Institute since 1942 when I first advanced the above view. The over-estimation with sample-cuts of 1 sq. ft. had been found to be very large (of the order of 62 per cent) in 1940, and it was decided to discard such extremely small sizes in future. But practically every year from 1941 to 1946 we have been conducting experiments with sample-cuts of various sizes ranging from 9 sq. ft. (1/4,840 acre) to 576 sq. ft. (1/76 acre approximately) or more, and in certain cases up to whole fields on various crops like *aus* (monsoon) and *aman* (winter) rice, jute, wheat, and sugar-cane. Each year evidence was accumulated about the extent and nature of over-estimation, and further reports were submitted to various Government departments. During my recent tour abroad, I gave a brief account of such work at Columbia University, New York, on May 7, 1946, and a somewhat fuller account before the Royal Statistical Society in London on July 16, 1946, where I presented a summary table, reproduced herewith, from which it appears that the over-estimation decreases as the size of the sample-cut is increased and becomes practically negligible for cuts of size larger than 40–50 sq. ft.

PERCENTAGE YIELD-RATES BASED ON SAMPLE-CUTS OF DIFFERENT SIZES

Size of cut (sq. ft)	Bengal jute, 1940 (320)	Bengal jute, 1941 (185)	U.P wheat, 1941 (178)	U.P wheat, 1942 (346)	Bengal rice, 1943–44 (40)	Average index (un-weighted)
9	103 8	116 1	121·4	118 1	113 3	114 7
18	—	—	111·6	109·4	—	110 5
25 27	—	100·7	—	109 0	—	105·0
36	—	—	100·1	99 0	112 1	103·7
48 49	95 5	95 3	—	—	—	95 4
54	—	—	—	96 0	—	96 0
64	—	105 9	—	—	—	—
81	—	—	—	93 6	—	—
135	—	—	99·9	—	—	—
144	99·6	96 4	—	—	101 2	—
225	—	*100 0*	97·4	—	—	—
256	*100·0*	—	—	—	—	—
324	—	—	—	*100·0*	—	—
576	—	—	*100·0*	—	*100·0*	—

N.B.—The size of the sample is given within brackets at the top of each column

Besides using various sizes of sample-cuts, we also studied the effect of using different methods of demarcating the sample-cut, such as pegs and ropes, rigid frames of triangular and square shapes, and semi-rigid frames. In 1944, Jitendra Mohan Sen Gupta, of the Statistical Laboratory, suggested obtaining circular-shaped cuts by using an arm rotating over a pivot with a light stylus attached at the end of the rotating arm to catch the plants. Several models were tried on the field, and in the present form the arm is of adjustable length so that concentric circular cuts of three or four sizes can be harvested at each spot. Standard sizes of 12·57, 50·27, 100·88 and 201·06 sq. ft. are being used at present.

I presented experimental material before the Royal Statistical Society, from which it appears that circular cuts of 2 ft. radius (area = 12·57 sq. ft.) leads to an over-estimation of the order of 14–15 per cent on an average when the work is done on an extensive scale by a large field-staff scattered over a whole province (for example, Bengal, comprising about 70,000 sq. miles). There is, however, practically no bias when the size is increased to a radius of 4 ft. (area = 50·27 sq. ft.). For example, in the work on *aman* (winter) rice in Bengal in 1945–46 comprising 2,569 sets of three concentric cuts, the weighted average for cuts of 50·27 sq. ft. was 99·7 per cent of the weighted average for cuts of 100·88 sq. ft. Along with such extensive experiments carried out by the ordinary field-staff, arrangements were also made to study the size bias in the case of work done under the direct supervision of trained statisticians. It is interesting to observe that in one series of experiments on *aman* rice in 1945–46 at three different centres the pooled average rate of yield based on 236 cuts was 1,183 lb. of rice (not in husk) per acre for circular cuts of 12·57 sq. ft. against a pooled average of 1,168 lb. per acre for cuts of 72 ft. × 72 ft. = 5,184 sq. ft. (a little less than 1/8 acre), showing that the over-estimation had become practically negligible.

To come back to the cause of the size bias, I am now inclined to rely more on the line of explanation offered by F. Yates[6] in the paper cited by Dr. Sukhatme. Discussing the observed bias in crop yields harvested from within hoops (of area 10 sq. ft.) supposed to have been thrown at random on fields in the United Provinces, Yates suggested: "The bulk of the bias, however, is probably due to the tendency, conscious or unconscious, to cast the hoop on the good parts of the crop". The fact that the over-estimation with cuts of small size becomes practically negligible when the work is done under adequate statistical supervision, but is quite appreciable when it is done by the ordinary field-staff, suggests the following explanation. It is possible that there are patches of greater fertility distributed either in a random manner or in a mildly patterned form. In locating the sample-cuts, ordinary investigators may unconsciously tend to favour these more fertile patches by slightly shifting the exact location of the 'random point' on the field. Under adequate supervision, it is possible that the location of the 'random point' is carried out in a proper manner, thus successfully eliminating this particular source of bias. Unconscious pulling in of plants on the border line (as suggested by me four years ago and recently repeated by Dr. Sukhatme) may also be a contributing factor of importance.

It is relevant in the present connexion to mention the danger of under-estimation in using comparatively large sample-cuts demarcated on the field with pegs and ropes. It is doubtful whether the ordinary field investigators can measure the sides of the square (or of whatever other shape of cut is used) with sufficient accuracy. Sagging of stretched ropes would reduce the actual area harvested and would lead to under-estimation. Then there is a real difficulty about the allowance to be made for the boundaries (called *ail* in India) between different fields. This point is particularly important in a province like Bengal, where the average size of individual fields is less than half an acre. In fact, the concept of the 'whole-field' is difficult to define in an unambiguous manner. The subject obviously requires further investigations.

Another point deserves notice. In recent work done by our field-staff, we found an over-estimation of about 15 per cent for cuts of size 12·57 sq. ft. Yates had reported an over-estimation of 13·9 per cent (with standard deviation of mean of 2 97 per cent) for hoops of size 10 sq. ft. These two results are in broad agreement. In Dr. Sukhatme's work the over-estimation was much higher, namely, 42 4 per cent (in both the series reported in *Nature*) for sample-cuts of size 12·5 sq. ft. Dr. Sukhatme has not given the standard error, but the much higher over-estimation suggests that his field-staff had greater bias than the Bengal field-staff. This naturally raises the question of validity of the results. In the Indian Statistical Institute great importance is attached to the field survey being conducted in the form of two (or more) interpenetrating but independent networks of samples, each of which furnishes an independent estimate and hence supplies information relating to the effective margin of error. I have discussed this point elsewhere[3] and would content myself by remarking that it would appear advisable to provide such controls in the schemes which are in Dr. Sukhatme's charge. This was also the advice given by R. A. Fisher in the memorandum to which I have already referred.

[1] *Nature*, **157**, 630 (1946)
[2] Hubback, J., "Sampling for Rice Yields in Bihar and Orissa", *Imp Agric Research Inst Pusa, Bull.* 166 (1927), recently reprinted in *Sankhya*, 7, 3, 281.
[3] Mahalanobis, P. C., *Sankhya*, 7, 3, 272.
[4] As stated in a memorandum submitted by Prof R. A. Fisher to the Imp. Coun. Agric Res (India) on March 2, 1945, and quoted by me in *Sankhya*, 7, 3, 269.
[5] Mahalanobis, P. C., *Phil Trans.*, B, **231**, 509 (p. 409).
[6] Yates, F., *Ann. Eug.*, 6, 2, 211.

MELLON INSTITUTE

ANNUAL REPORT FOR 1945

ADDITIONAL interest is lent to the thirty-third annual report of the director of the Mellon Institute, Pittsburgh, Pennsylvania, Dr. E. R. Weidlein, covering the year ended February 28, 1946, by current discussions on the possibility of developing similar institutions in Great Britain (see p. 797 of this issue of *Nature*). Since 1942, the activities of the Institute have been concerned mainly with urgent problems of war science and technology, and during the year under review there were only twenty-nine individual and fifty-three multiple fellowships operating, of which thirty-two had been proceeding for ten years or more and a further twenty-eight for five years. The industrial research staff of 261 fellows and 264 assistants is an increase of nineteen fellows and thirty-two assistants on 1944–45. Fellowships on adhesives, optical cements and silica gel began during the year, and the programme on adhesives was completed, as well as fellowships on cellulosic moulding, constructional resins, disinfectants, phenol chemistry and tar derivatives; the last two have been merged in the multiple fellowship on tar synthetics.

From this long report it is possible to select for mention only a few items illustrating the wide range of activities. An investigation on the development of a vitreous enamel coating for fixed wire-wound resistors, capable of high resistance to thermal shock and moisture, undertaken at the instance of the War Metallurgy Committee of the National Research Council, led to the use as coating of a silicone paste originated by a fellowship of the Corning Glass Works. This fellowship has now been returned to work on porcelain enamels and has already led to the development of a high-titanium cover-coat enamel of very high opacity and resistance to acid. Another fellowship has been concerned with the reactions occurring during the sintering of iron powder compacts, while the American Iron and Steel Institute's multiple fellowship on acid recovery has completed eight years study, in co-operation with public health officials and industry, of waste pickle liquor. A multiple fellowship on magnesium is concerned with fundamental studies on magnesium and its alloying properties, with the prime purpose of producing alloys with superior properties. New nickel compounds and catalysts of special promise are being prepared under another project, and evaluated in co-operative programmes with industrial and government laboratories. This inclusive multiple fellowship is sponsored by the International Nickel Co.

Work in coal chemistry has led to the discovery that the gradual deterioration in the quality of re-cycle benzene is due to the preferential accumulation of paraffins. Many advances have been made in gas by-products, and a thorough study made of the polymerization of vinylnaphthalene which, contrary to published statements, is found to be a rapid process. New processes for purifying benzene, a novel type of 1-in. laboratory column, and a universal type 3-in. fractionating column are other achievements in this field, which includes a broad programme on alkylation and dealkylation from which the process of ethylating benzene at Koluta came.

Work in petroleum technology has included fundamental theoretical studies of distillation, particularly of rectification processes, and investigations on the physical properties of petroleum waxes, the mechanism of catalytic reactions and the nature and structure of catalyst surfaces. New and improved lubricants have been developed for aviation instruments as well as new testing methods for such products, and the report includes some information on the synthetic lubricants developed under the organic synthesis multiple fellowship of the Carbide and Carbon Chemicals Corporation, which has now operated continuously for thirty-two years. Progress in applications of 'Vinylite' resins from dispersions has been accelerated, and extensive studies of the effect of the composition of the liquid vehicle on the viscosity of the dispersion have provided a sound technical basis for formulating the coatings. Investigation of the chemistry of allyl compounds has led to industrial processes for 2 : 3-dichloropropanol, 3-chloro-1 : 2-propanediol and epichlorohydrin ; also phenylmorpholine has been produced on a sufficient scale for development. Military requirements initiated researches for non-ionic surface-active materials, and the vitamin section of the Heinz multiple fellowship on food varieties has thrown light on the effects of storage on the vitamin content of regular and fortified strained foods. The value of yeast as a therapeutic agent and as a source for vitamins, and the improvement of malt processing, have also been investigated.

A programme assigned to the Institute by the Air-Sea Rescue Agency of the Armed Services has led to the development of a treated superfine "Fiberglas" which promises to replace kapok for use in life-jackets on all naval vessels, and also for other purposes where its fire-proof qualities are of first importance. Careful studies on methods of evaluating buoyancy and of the role of packing density and column heights have led to a broader understanding of the mode of function of fibrous buoyant materials. Correlated studies of the physical and chemical properties of cotton fibres are also in progress, and during the War a continuous programme of testing threads and tapes for their ability to resist tropical conditions was carried out. A new field is being opened up in the use of recovered synthetic fibres to make textiles with desirable properties of their own. The utilization of industrial proteins, including stabilized zein resins, as shellac substitutes, and the industrial uses of a chemically modified zein, the development of improved catalysts for the synthesis of butadiene from ethyl alcohol and of organic coating compositions for lining the wing tanks of aeroplanes as well as for steel to permit its use under conditions of severe corrosion, have all received attention ; while investigations on the organosilicon compounds have led to the use of polysiloxane fluids as anti-foaming agents in petroleum products and moulding rubber and organic plastics.

Besides referring to the work of the fellowship on chemical hygiene, particularly in the study of newly available chemicals, from the point of view of hazards to health, the report includes notes on the Industrial Hygiene Foundation, which has strengthened its staff of specialists and completed a study of the control of sweeping dust in the pottery industry and of the technique of determining the safe limits of silica content in industrial dusts. Reference is again made to the synthesis of new antimalarial drugs, particularly hydroxyethyl analogues of the pamoquine series, involving the synthesis of 8-amino-6-hydroxyethoxyquinoline and the use of a new hydroxyethylating agent, by the Department of Research in Pure Chemistry. An examination of the lepidyl carbinols, the preparation of 4-(*p*-dialkylaminobenzylidene)- and 4-(*p*-dialkylaminobenzyl)-aminoquinolines and the function of alloxan in causing experimental diabetes in animals, in the course of which two colour tests for alloxan have been developed, are other subjects under investigation in the Department.

ONTARIO RESEARCH FOUNDATION

ANNUAL REPORT FOR 1945

THE annual report for 1945 of the director of research of the Ontario Research Foundation at Toronto, Dr. H. B. Speakman, refers to the transition period through which the Foundation passed during that year Steps taken soon after the termination of hostilities to restore to normal the available space enabled the Foundation to respond to the increased demand for fellowship facilities, and before the close of the year the available laboratory space was fully occupied. Available statistics show that there are about eleven thousand industrial units in Ontario, of which only three hundred are large enough to justify the maintenance either of a research laboratory or a fellowship unit at the Foundation, and some of these consist of branch companies looking to a parent company in the United States for research and technical direction.

Besides the twenty fellowships which tax the Foundation's present facilities, many firms use the Foundation for short-term investigations; but the director, in noting that the external income of the Foundation is now about 57 per cent of the total revenue, while investment income has decreased by 18 per cent since 1938 and costs have almost doubled, points out that in consequence the Foundation's ability to initiate and sustain investigation in fields of provincial importance, rather than of immediate concern to an industry or a firm, is diminishing. He expresses his firm conviction that societies will prosper in the future in so far as they are willing to authorize research expenditure on a reasonably liberal and long-term basis.

Reviewing the work carried on during the year, the report refers to an investigation undertaken in the Division of Biochemistry to explore the possibilities of using Canadian linseed oil in the manufacture of shortening. Much effort has been devoted to the causes of the objectionable flavour developed by the hydrogenated oil on storage, and this work has led to a wider use of the Beckman ultra-violet spectrophotometer in the laboratories of the Foundation. Fellowships have been established in the Division for the investigation of problems associated with the production of sole leather, and for the development of pharmaceutical products. In the Division of Chemistry, the general organic laboratory was concerned with the investigation of short-term problems submitted by more than seventy firms. A section for statistical quality control was established at the beginning of the year in an effort to make available to industrialists in the Province methods which had proved of great value in the manufacture of munitions. Washable papers of two qualities have been developed under the Canadian Wallpaper Manufacturers' Fellowship, while in the laboratory supported by the Consumers' Gas Co. of Toronto, attention has been concentrated on more economical methods for the further purification of city gas. A dental materials research laboratory has studied reactions involved when plastics of the methyl methacrylate type are used in manufacturing dentures, and in the Moore Corporation Fellowship improved formulæ have been developed for the production of hot-melt inks for carbon paper, and a new type of ink is also being developed. The Standard Chemical Co., Ltd., has established a fellowship for the study of cellulose derivatives; the Sterling Rubber Co. Fellowship, which led to the development of pilot-plant for the manufacture of plastics from wood, was terminated in September. The facilities of the Department of Metallurgy have been radically re-arranged.

The Department of Parasitology continued its work on the blood parasites of ruffed grouse, and the strain of malaria discovered in ruffed grouse last year has been transferred to birds raised in captivity and to canaries, ducks and turkeys. In the Department of Physiography more time has been given to writing up in permanent form the results of the investigation of the physiography of southern Ontario. In the Textiles Department experience gained during the War in developing and testing fabrics for specific functions is already being used to advantage in peace-time projects. The York Knitting Mills Fellowship has concentrated attention on problems associated with the introduction to Canada of the Kray process for producing unshrinkable wool, and the Canadian Industries Ltd. Fellowship is devoted to a study of the fundamental characteristics of nylon yarn and fabrics.

PRECISION-GAUGE LABORATORIES IN THE UNITED STATES

A REPORT in *Industrial and Engineering Chemistry* of October describes an interesting and important development in the establishment of precision-gauge laboratories throughout the United States for training and inspection. This experiment should not only be noted in British plans for university expansion, but may also provide a more convincing reason for the success of the scientific instruments industry in the United States than that of the existence of large consuming firms, to which F. Rothbarth in the *Economic Journal* attributes the profitableness of the mass production of scientific instruments in the United States.

The new development goes back to the establishment of precision-gauge laboratories in the First World War to eliminate troubles due to faulty precision-machine materials through the use of inaccurate or worn gauges. At that time the idea was conceived of maintaining permanent laboratories with regular training facilities under the administration of colleges and universities. The first of these laboratories was set up at Stanford University in 1930, with surplus stocks gathered from arsenals. The success of the project led to expansion of the programme, with a second ordnance educational unit established at the University of Michigan in 1936. In 1940 there were nine laboratories in operation, and during the Second World War these were expanded and used entirely by the Ordnance Department. With the end of the War, the laboratories are once again operating in conjunction with the universities; in addition to the two mentioned, the major laboratories are located at New York University, Georgia School of Technology, University of Cincinnati, Washington University, Illinois Institute of Technology, Carnegie Institute of Technology, and Case School of Applied Science. Operations are now in progress to convert laboratories set up in the other four ordnance districts during the War to similar ordnance-educational units, as well as to establish additional organisations in the districts where use of the laboratories is especially heavy.

The precision-gauge laboratories are set up, with the institution providing space, light, heat, furniture, and security for the equipment. The schools furnish study courses on precision measurement and inspection, and they can use the equipment in research and consultation, and in standard reference laboratories for the inspection and checking of precision equipment for industry. Provision is made for co-operation in industrial research projects. As non-profit organisations the precision-gauge laboratories can act as referees in disagreements over the precision of tolerances in gauges or even in parts purchased from manufacturers. The Ordnance Department has the use of the laboratories for training students, and each institution is expected to organise an Ordnance unit, the use of the laboratory reverting exclusively to Ordnance in time of war.

One of these laboratories is administered by the Armour Research Foundation of the Illinois Institute of Technology, under the direction of N. C. Penfold, head of the Mechanical Engineering Division of the foundation. The laboratory is housed in the Engineering Building in a room air-conditioned to 68° ± 1° F. and a relative humidity of 45 per cent. Among major items of equipment are gauge blocks, calibrated by the U S. National Bureau of Standards, with an accuracy of four millionths of an inch. These blocks are used only as reference standards, never in actual production, and are themselves checked regularly against the Chicago laboratory's master set, used for that purpose only and accurate to two millionths of an inch. Both internal and external comparators with accuracies of ten and twenty millionths of an inch are included. Two optical contour projectors, for shadowgraph observations of profiles at magnifications of 10 to 100, can be used in measurement of radii, angles and leads on screw threads, or any contours that can be laid out. Other instruments include a length-measurement machine for determining directly diameters or lengths up to 48 inches to an accuracy of ten millionths of an inch, optical flats, supermicrometers, hardness testers, toolmakers' microscopes, height gauges, sine bars for measuring angles such as those of taper gauge plugs, and a variety of callipers, levels, and calibration instruments.

Although the Division of Physics and Electrical Engineering of the National Research Council of Canada during the War has carried out some testing and calibration of the same type, there has been no corresponding link up of such testing and training work there or in Great Britain. The growing importance of precision instruments in all fields of industrial and scientific research should stimulate similar developments in Britain; and it should be noted that at a recent conference of the Instrument Society of America the further suggestion was advanced by Dr. R. H. Muller of New York University for the establishment of an Institute for Instrument Research embracing studies in all fields of instrumentation.

SOCIAL LIFE IN ROMAN BRITAIN*

ROMAN Britain is only the prelude to the drama of English history, of which the first scene must be England after the Saxon conquest. The Romans vanished, leaving their roads, their ruins, and here and there the potent Christian seed. But they did not found England as Cæsar founded France.

The social life of the Province was divided geographically into two parts: the Civil Zone, inhabited by a partially Romanized society, dwelling among the gently undulating and fertile lands of the Midlands, the south and the east; and the Military Zone of the more barren and mountainous north and west. In the Civil Zone stood the towns and the villas that carried Roman civilization into the countryside; it was a region of peace and safety, with few armed men and few fortified dwellings. In the Military Zone, on the other hand, the army of occupation, based on the fortress towns of York, Chester and Caerleon, patrolled Wales and the Pennine moorlands, and guarded the Great Wall that stretched from Solway to the mouth of Tyne.

This distinction between the Civil and Military Zones in Roman Britain answered to the primary geographical difference between south-east and north-west, which since earliest ages had dictated the place and character of human settlement, and the speed and extent of each successive conquest of the island.

* Synopsis of a Friday evening discourse by Dr. G. M. Trevelyan, O.M., delivered on November 16.

But although the south-east could show a greater number of inhabitants and a higher stage of civilization, even in that favoured half of the Province of Britain, not very much was done under the rule of the Cæsars to reclaim new lands. The heavy clay soils with their forests of oak and impenetrable tangle of underwood, and the marshy bottoms of the valleys, still prevented human settlement in regions that were afterwards the richest cornlands in England.

Indeed, taking the island as a whole, the map of human occupation was not very different in Roman times from the map of the Iron Age.

But if the denser forests set a limit to Roman agriculture, nothing could turn aside the Roman road. The Imperial highways, constructed by those indefatigable and skilled engineers, the soldiery of Rome, were the chief weapon of her military and political rule; and they were essential to the plantation of the cities which formed the chief contribution of the conquerors to the economic and social life of the barbarian island.

Combined into one society by the system of old and new roads, primitive and Romanized Briton dwelt beneath the shadow of that august Empire, international in its large, hard heart, tolerant of all save rebellion; for Rome, while she erected her own monumental civilization in cities, forts, villas, inscriptions and statues up and down the conquered land, spared to the subject his own gods, his own tribes, his chieftains and his ways of life, hoping merely that the barbarian would learn to imitate the civilized model so impressively set up before his eyes.

These little towns were planted and watered by the Government in the hope that they would grow, and soon be able to carry the weight of all this municipal building and expense. But their economic development hung fire, and the rural hinterland, itself but thinly inhabited, continued to pay in taxes for the exotic urban display. The cities remained parasitic on the countryside. Except London, with its cosmopolitan port, they were none of them great makers of wealth, and their public buildings were out of all proportion to their economic life. It is not, therefore, surprising that in the middle of the third century A.D. the cities began to decay, and Rome's policy with regard to them changed. As on the Continent of Europe at the same period, the Imperial Government began to neglect and oppress the towns that had formerly been its favourites. Henceforth the rural villa with its farm life was regarded as better than the city as a means of Romanizing a passively recalcitrant countryside.

The Roman villa stands in rural solitude, amid its own fields and woods. It is a self-contained agricultural and social unit. Its owner is a Romanized Briton. His dwelling-house, where he lives with his family and his domestic slaves, resembles one of the town houses, with red-tiled roofs, corridors, mosaic and tessellated pavements, and chambers warmed by hypocausts. The whole establishment bears some resemblance to a 'country house' with its home-farm in later England, and the owner's life, divided between field sports and directing the operations of agriculture, is not altogether unlike that of a 'squire'. But the atmosphere is less free and neighbourly, for there are no tenant farmers and there is no 'village' attached to the villa. It is all one large home-farm, a little too like one of the ill-omened *latifundia* of Italy, for it is cultivated chiefly by slaves.

We must not suppose that the villa was the commonest, though it was the most remarkable, type of agricultural life in Roman Britain. The greater part of the population still lived, as of old, either in isolated farms of a primitive kind, or in native village communities. The inhabitants still cultivated their small, enclosed fields, the ghostly lines of which have been revealed by air-photography cutting athwart the larger fields of a later Britain.

What was the total population of Roman Britain ? We do not know. Scholarly conjecture has placed it sometimes at half a million, sometimes at a million. At any rate there were many fewer inhabitants than at the end of the Saxon period, when a vast acreage of the best land had been won from the wilderness, and hundreds of villages had been planted on land that was forest or marsh when the Romans left the Island. Students of Domesday Book have calculated that there may have been a million and a half folk in England in the age of Harold and William of Normandy. Even that estimate may be incorrect, though it has something to go upon. But whatever the numbers may have been in the England of Domesday, it is certain there were many fewer in the Britain ruled by the Cæsars.

JOHANN LUDWIG STEINER AND THE HISTORY OF THE ACHROMATIC LENS

THE Naturforschende Gesellschaft in Zurich was founded on August 31, 1746 (see *Nature*, October 19, p. 559). Among the first eleven members was Johann Ludwig Steiner—perhaps the originator of the Society—a watchmaker and optician in Zurich. Goethe in his "Farbenlehre" says in a survey of the history of achromatic lenses that the practical and theoretical work of Boscovich and Steiner will not be forgotten ; but Steiner's has already been forgotten. This comment by Goethe has been followed up by Prof. D. Brinkmann, of the University of Zurich, and in an article entitled "Johann Ludwig Steiner, a forgotten founder of the Naturforschende Gesellschaft in Zurich", he has published the results of his investigations (*Prisma*, No. 5, 1946).

Steiner, the watchmaker and optician, visited England as a young man and was in touch with members of the Royal Society. The impression he received never left him, and probably induced him to propose the foundation of the Swiss Society, and in one of his books, a kind of encyclopædia, which he pretends to have translated from the English, he makes this proposal. Two years later the Society was founded.

Steiner's contribution to the development of achromatic lenses is contained in his book "Abhandlungen von den Vergrösserungsgläsern" (1753), which is partly a translation of Henry Baker's book "The Microscope Made Easy" (1743). In an appendix, Steiner develops his own ideas on lenses and microscopes. Baker, who received the Copley Medal of the Royal Society for his work on crystallization in salt solutions, was a son-in-law of Daniel Defoe, with whom he edited the *Spectator and Weekly Journal*.

Steiner (1711–79) was a splendid artisan. He surpassed Vaucanson in the construction of artificial automats. He built microscopes with exchangeable lenses, rotating concave and plane mirrors and apparatus for the projection of the magnified picture on a screen. He constructed also the first magic lantern with moving pictures.

A third of Steiner's books refers to the treatise of the famous mathematician Leonhard Euler at the Academy of Science in Berlin, which for the first time showed theoretically the possibility of the construction of achromatic lenses. Newton had denied this possibility. To prove that Newton was right, the optician J. Dolland in London made a practical experiment with flint and crown glass—and constructed in this way, against his wish, the first real achromatic lens. Steiner supplemented Euler's treatise with his own experiences and inventions.

ARNOLD HAHN

NORSE CULTURE IN GREENLAND

THE first of the works[1] under notice* is an elaborate survey of all the ancient Norse buildings known in Greenland, together with a summary of the relics found in them and an estimate of the stock carried on each farm. It is a most valuable and comprehensive work, and no student can hope to understand the Norse colonization of Greenland without consulting it.

The second book[2] is a clear and valuable account of the excavation of several Norse farms in the old Eastern settlement and should be read in connexion with Aage Roussell's earlier work.

The remaining two works[3,4] are of very great anthropological and also historical importance. In them such knowledge as can be obtained from the comparatively few skeletons of the old Norse colonists which have so far been recovered is carefully examined and summarized. The conclusions arrived at by Fischer-Møller in the first work are very definite and give us a completely different picture from that suggested by the late Dr. Hansen, who examined the fragmentary human remains found at Herjolfsness in the extreme south of the country. Hansen supposed that the Norse colonists died out from malnutrition, degeneracy, disease and inability to breed. Fischer-Møller, while not denying that there may have been some degeneracy and malnutrition at Herjolfsness, is emphatically of the opinion that there is no trace of this in the northern (called 'western' by the medieval Norsemen) settlement up to the time when it was found to be abandoned about the middle of the fourteenth century. He suggests, with proper caution, that all the evidence goes to show that the population was not killed off by disease or by the Eskimos, that it did not merge in the Eskimo

*Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland.

[1] Bd 89, Nr. 1. Farms and Churches in the Mediaeval Norse Settlements of Greenland By Aage Roussell Appendix The Osseous Material from Austmannadal and Tungmeralik, by Magnus Degerbøl. (Researches into Norse Culture in Greenland.) Pp. 356. 17 kr.

[2] Bd 90, Nr. 1: Inland Farms in the Norse East Settlement—Archæological Investigations in Julianehaab District, Summer 1939. By Christen Leif Vebæk. Appendix. Animal Bones from Inland Farms in the East Settlement, by Magnus Degerbøl. (Researches into Norse Culture in Greenland) Pp. 120. 5 50 kr.

[3] Bd. 89, Nr. 2· The Mediaeval Norse Settlements in Greenland—Anthropological Investigations, by K. Fischer-Møller (Researches into Norse Culture in Greenland) Pp. 84+22 plates. 5 kr.

[4] Bd. 89, Nr. 3 The Mediaeval Norsemen at Gardar—Anthropological Investigation. By K. Bröste and K. Fischer-Møller; with Dental Notes and a Chapter on the Dentition, by P. O. Pedersen. (Researches into Norse Culture in Greenland.) Pp. 62+30 plates. 4.50 kr.

(København: C. A. Reitzels Forlag, 1941–1944.)

stock by interbreeding, but that it probably emigrated in mass. Since it did not return to the southern (eastern) settlement, or to Iceland, or to anywhere else that we know of, it seems clear that, if Fischer-Møller is right, which I feel to be most probable, it must have attempted a migration to the American continent itself. In Newfoundland or Labrador, beside the Great Lakes or Hudson Bay, we must look for traces of the Norsemen from West Greenland.

People in Britain must surely feel some pleasure at this conclusion. The dismal picture of decay and failure drawn from the interpretation of the Herjolfsness material is changed to one of expectancy and interest in a new problem. It is changed also to one of almost personal pride, for the examination of the Greenland skulls makes it clear that Celtic blood was strong in the old medieval settlers as it was also in medieval Iceland. When this last expedition rowed out westward over the cold grey waters of Baffin Bay, there were those aboard it who remembered the old tales of Tir nan og and the bright lands beyond the sunset. T. C. LETHBRIDGE

POPULATION DENSITY OF THE SHEEP BLOWFLY IN AUSTRALIA

DARCY GILMOUR, D. F. Waterhouse and G. A. McIntyre, in a paper entitled "An Account of Experiments Undertaken to Determine the Natural Population Density of the Sheep Blowfly, *Lucilia cuprina* Wied.", have endeavoured to assess the value of trapping as a means of controlling those insects (Commonwealth Coun. Sci. Ind. Research, Bull. 195; 1946). The method used was that of liberating a known number of marked flies and of sampling by means of traps the population in an area surrounding the point of release. The number of blowflies within the area was then calculated by multiplying the ratio of the unmarked to marked flies caught in the traps by the number of marked flies liberated in the trapping area. Some 102 traps were used, and these were disposed at equal intervals in a circle of 6 miles diameter. Some 40,000 flies were liberated at the centre of this circle one day before the trapping began. The marking of the blowflies was by staining them with an alcoholic solution of suitable dyes. Two treatments were given: the first with an electric power sprayer and the second with a hand atomizer. In the main experiments, the diameter of the circle was increased to 8 miles.

The results of four experiments made between November 1941 and March 1942 showed that the natural blowfly population varied between 0·3 and 5·7 flies per acre. The distribution of the stained flies was found to agree fairly well with a theoretical distribution curve based on the assumption that the flies moved outwards at random. The rate of dispersal of the stained flies varied from one experiment to another, the differences showing some correlation with meteorological conditions.

The error involved in the method of estimating population density was of the order of about 20 per cent. In addition, the possibility that an additional error has to be allowed for cannot be overlooked, since the stained blowflies did not behave exactly as the natural population. There is also a further error arising from the fact that the validity of the method of estimation is based on the assumption that, activity being uniform, the catch of each trap varies directly with the population density. This may not be the case, and there is some evidence that could be interpreted as indicating that the catches of stained flies in the central traps, where the population is high, are disproportionately large. At present the available data are insufficient to evaluate these factors; but the authors consider that the results they obtained give a tolerably reliable estimation of the true fly population. It is noteworthy that an analysis of the variation between the catches of individual traps shows that some of the variability was due to local differences in the natural population.

While the experiments were not designed to record the maximum range of flight, it is worth noting that the greatest distance from the point of release at which flies were taken was 4·7 miles—a distance which they covered in less than 30 hours.

FORESTRY IN SIERRA LEONE

WITH the end of the War has come the task of the switchover from war production to civil requirements in the case of the forestry services of the Empire. In the Report on Forest Administration of Sierra Leone for the Year 1945 (Government Printers, Freetown, 1946) we see that this process is being undertaken, one of the objects being to conserve the natural resources—forests and water—of the country wherever necessary and wherever possible.

The report states—and it has been often repeated in the past for other regions of the world—that the Colony is suffering acutely from the uncontrolled destruction of hill forests by bush and grass fires. It is held that conservation by controlling these two evils is the greatest need in the country to-day, and until it becomes effective, agriculture instead of being a thriving industry will continue its downward trend. Much of the country is already so degraded that only bare subsistence farming is possible, and that for a very short time now. Landslides and floods are becoming a serious menace to property. The cause and effect are apparent and the remedy is obvious. It will take years, says the writer, to rebuild the soil and water resources of the country; but it is possible, when effected, that a stable agriculture will ensue.

The policy of the Forestry Department has been approved by the Development Council and incorporated into the general plan of the country. It lays down a programme of work for the next ten years and provides the basis for more detailed regional planning. It has been framed in accordance with the long-term policy accepted by Government, the two main objectives being the expansion of the conservation programme, and a continuance of forest utilization started during the War, to ensure self-sufficiency in timber. Certain sums of money have been allocated to these two objectives, which are closely related.

As the report definitely states, constant vigilance will be required to ensure that the conservation programme is not sacrificed to utilization, as has been so often the case in the past. During the War, in this and other Colonies, the sacrifice was almost inevitable; but that demand has now ceased, and it should be the aim of the Department that the objects of the ten-year programme be firmly adhered to, and that in every case utilization be made subordinate to the programme of soil conservation.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 2

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C 2), at 5 p m.—Capt J. C Taylor "Marine Life-Saving Appliances" (Thomas Gray Lecture).

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p m.—Dr. H. G Taylor. "Copper Alloy Resistance Materials".

Tuesday, December 3

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p m —Sir Harold Spencer Jones, F R S "Three Astronomical Centenaries, 2, John Flamsteed, first Astronomer Royal, Born 1646".*

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mr. F E Warner "Nitric Acid Production".

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 30 p m —Prof. R A. Fisher, F.R S.. "The Present Position of the Rhesus Blood Group Factor".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p m — Mr E. G. Hancock 'Synthetic Resins from Polyhydroxy Phenols".

TEXTILE INSTITUTE, BELFAST BRANCH (at the College of Technology, Belfast), at 7.30 p m.—Mr S A G. Caldwell: "Further Developments in Flax Yarn Production"

Wednesday, December 4

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S W.7), at 4.30 p m —Dr C. E. P Brooks "The Library of the Meteorological Office", Dr John W. T Walsh: "Some Problems in the Alphabetical Arrangement of Proper Names".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C 2), at 5 p.m.—Dr L. H Lampitt: "Sir William Jackson Pope—his Influence on Scientific Organisation" (Sir William Jackson Pope Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C 2), at 5 30 p.m.—Dr. H. G. Booker: "The Elements of Wave Propagation Using the Impedance Concept".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 30 p m —Discussion on "The Application of Statistical Methods to Food Problems".

Thursday, December 5

ROYAL SOCIETY OF ARTS, INDIA AND BURMA SECTION (joint meeting with the EAST INDIA ASSOCIATION, at John Adam Street, Adelphi, London, W C 2), at 2.30 p.m —Mr A. H. Seymour: "Some Supply Aspects of Rehabilitation in Post-War Burma".

CHADWICK PUBLIC LECTURE (at St. Mary's Hospital Medical School, Norfolk Place, Praed Street, London, W 2), at 4.30 p m.—Colonel C. H. Stuart-Harris "The Problem of Prevention of Acute Diseases of the Respiratory Tract, with particular reference to Influenza" (Malcolm Morris Memorial Lecture) *

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. Kathleen Lonsdale, F.R S.. "What Chemistry Owes to X-Rays, 1, Physical, Inorganic and Analytical Chemistry".*

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C.1), at 5.15 p m.—Mr R. Stone: "On the Interdependence of Blocks of Transactions".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p.m —Mr. W. Szwander. "Power Supply for Generating Station Auxiliary Services".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S W.1), at 6 p m.—Mr. J. K. Hardy. "Protection of Aircraft Against Ice".

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 7 p.m.—Mr. C. V. Ward: "Dust and Fly Control and its Relationship to Air Conditioning in the Textile Industry".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p m.—Prof. M Stacey: "Macromolecules Synthesised by Micro-organisms" (Tilden Lecture).

Friday, December 6

ASSOCIATION OF APPLIED BIOLOGISTS (at the Imperial College of Science and Technology, South Kensington, London, S.W.7). At 11 a.m. (in the Survey Lecture Theatre, Royal School of Mines, Prince Consort Road).—Mr. A. R. Wilson, Mr. A. E. W. Boyd, Mr. J G. Mitchell and Mr. W. S. Greaves: "Potato Haulm Destruction, with special reference to the Use of Tar Acid Compounds", at 2 15 p.m. (in the Main Lecture Theatre, Huxley Building, Exhibition Road).—Prof. G. E. Blackman: "Recent Developments in Chemical Methods of Weed Control".

BIOCHEMICAL SOCIETY (at the National Institute for Medical Research, Hampstead, London, N.W.3), at 1.30 p.m.—Scientific Papers.

PHYSICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S W.7), at 5 p.m.—Dr. R. C. Brown: "Fundamental Concepts concerning Surface Tension and Capillarity".

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the MEASUREMENTS AND TRANSMISSION SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Desirable Features of Protective Relays" (to be opened by Mr. C. Ryder and Mr. F. H. Birch).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St James's Park, London, S W 1), at 5.30 p.m —Mr. H. O. Farmer "Free-Piston Compressor-Engines"

ROYAL STATISTICAL SOCIETY, INDUSTRIAL APPLICATIONS SECTION LONDON GROUP (at the E L M.A Lighting Service Bureau, 2 Savoy Hill, London, W C.2), at 6 p.m —Mr. W. Bennett: "Statistics in America—Factory Organisation".

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W 1), at 6 p m.—Mr F Kenneth Hare: "The Geomorphology of parts of the Middle Thames Area" (to be read by Prof. S. W Wooldridge).

CHEMICAL SOCIETY, LIVERPOOL BRANCH (in the Lecture Theatre, The University, Liverpool), at 6 30 p.m —Dr J. P Baxter: "Atomic Energy".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Manchester), at 6 30 p.m —Members of the staff of Benger's, Ltd. Short Papers on "Enzymes in the Food Industry".

INSTITUTE OF ECONOMIC ENGINEERING, MIDLAND REGION (in Room 7, Chamber of Commerce, 95 New Street, Birmingham), at 7 p.m.—Annual General Meeting.

TEXTILE INSTITUTE, DUBLIN BRANCH (at the Mansion House, Dublin), at 7 30 p m —Mr A. T. Woods "Fuel Problems"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m —Prof Thomas Bodkin: 'A New Approach to the Fine Arts in University Education".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

LECTURER IN MECHANICAL ENGINEERING—The Registrar, The University, Sheffield (December 7)

LECTURERS (2) IN ZOOLOGY (Grade IIc or IIb)—The Secretary, The University, Edmund Street, Birmingham 3 (December 7)

ASSISTANT (administrative) in the Secretariat provided by the Agricultural Research Council for the Inter-Departmental Insecticide Committees—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W 1 (December 9)

ASSISTANT ANALYST (male) in the County Chemical Laboratory—The Clerk to the County Council, County Buildings, Stafford (December 10).

TEACHER (temporary) OF MECHANICAL ENGINEERING SUBJECTS in the Secondary (Technical) School, Hackney Technical Institute, Dalston Lane, London, E.8—The Education Officer (T 1), County Hall, Westminster Bridge, London, S.E.1 (December 13).

DENTAL RESEARCH TECHNICIAN for experimental work with dental techniques and materials—The Dental Assistant Dean, University of Bristol Dental Hospital, Lower Maudlin Street, Bristol 1 (December 14).

ASSISTANT LECTURER IN PHYSICS—The Principal, Royal Holloway College, Englefield Green, Surrey (December 15).

BIOCHEMIST in the Department of Pathology—The Superintendent-Secretary, Royal Infirmary, Bolton (December 17)

CHIEF MECHANICAL AND ELECTRICAL ENGINEER in the Production Department of the National Coal Board in London—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W C.2, quoting C.659A (December 20).

PRINCIPAL SCIENTIFIC OFFICERS in the Scientific Adviser's Department of the Air Ministry to deal with operational and administrative research problems in the Royal Air Force—The Secretary, Civil Service Commissioners, 6 Burlington Gardens, London, W.1, quoting No 1694 (December 21).

LECTURER, and an ASSISTANT LECTURER, IN PHYSIOLOGY—The Registrar, The University, Sheffield (December 21).

LECTURER IN CHEMISTRY—The Principal, Birmingham Central Technical College, Suffolk Street, Birmingham 1 (December 21)

RESEARCH PHYSICISTS on the staff of the Division of Radiophysics, Council for Scientific and Industrial Research, Sydney, for work on (*a*) radio propagation, (*b*) vacuum physics, (*c*) applications of radio and radar techniques—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting Appointment No. 1039 (December 30).

PRINCIPAL RESEARCH OFFICER (Senior Physicist), Division of Aeronautics, Council for Scientific and Industrial Research, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W C.2, quoting Appointment No. 1034 (December 30).

READERSHIP IN GEOLOGY, and a READERSHIP IN GEOGRAPHY, both tenable at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 31).

CHAIR OF GEOGRAPHY tenable at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 14).

PRINCIPAL—The Secretaries, Paisley Technical College, 3 County Place, Paisley (January 15)

PROFESSOR OF CHILD HEALTH—The Registrar, The University, Manchester 13 (January 21).

PROFESSOR OF FORESTRY—The Secretary and Registrar, University College of North Wales, Bangor (January 31)

CHAIR OF PHYSIOLOGY—The Bursar, Royal Veterinary College, Royal College Street, London, N.W.1 (March 1).

LECTURER IN ZOOLOGY—The Registrar, Municipal College, Portsmouth.

LECTURERS (3) IN MECHANICAL ENGINEERING at Howard College, Durban—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W C.1.

PRINCIPAL PROFESSIONAL OFFICER at the Government Metallurgical Laboratory, University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

LECTURERS IN (*a*) MATHEMATICS, (*b*) PHYSICS, (*c*) CHEMISTRY—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1

PHYSICAL CHEMIST to conduct research on corrosion problems—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W 1, quoting 'Chemistry Department'

SENIOR LECTURER IN CHEMISTRY, and an ASSISTANT LECTURER IN CHEMISTRY, in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W C 2

LECTURER IN PHYSIOLOGY—The Registrar, University College, Nottingham

ASSISTANT BIOCHEMIST for Physical Chemistry Department—The Secretary, Mount Vernon Hospital and the Radium Institute, Northwood, Middx

RESEARCH CHEMIST with experience in soil science and crop nutrition to conduct and supervise research, field and laboratory work in connexion with hop research work—The Secretary-Registrar, Wye College, Wye, Ashford, Kent

RADIOGRAPHER to take charge of X-ray Section—The Director, Medical Research Council Pneumokoniosis Research Unit, 32 The Parade, Cardiff

EXECUTIVE SECRETARY—The Hon Secretaries, Royal Meteorological Society, 49 Cromwell Road, London, S W.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Society of Animal Production Reports —Third Meeting, 21st February 1945, General Topic Meat, Fourth Meeting, 17th July 1945, General Topic British Pig Production Pp 85. (Edinburgh: British Society of Animal Production, Imperial Bureau of Animal Breeding and Genetics, 1946) 2s 6d. [305

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THE ATOMIC ENERGY ACT

THE Atomic Energy Act has become law, and many of its provisions affect, or may affect, the work of scientific men in Great Britain. Most clauses of the Act have no immediate effect beyond conferring certain powers of control on the Minister of Supply. Their practical consequences cannot be assessed until the Minister issues the orders which the Act authorizes him to make. The attitude of the Prime Minister and the Minister of Supply in the Commons debate, on which we commented recently in the "News and Views" column (*Nature*, Oct. 19, p. 545), has done much to reassure scientific men that it is the intention of the Government to work the new powers with the least possible interference with the freedom of science.

The only important section of the Act to become effective at once is Clause 11, which prohibits the unauthorized communication of information on certain matters. It should be noticed that this prohibition is therefore already in operation; and exemptions from it are possible only by administrative order, to be issued by the Minister.

The field covered by the prohibition would appear to be very narrow and far removed from academic research, since the clause refers to "plant . . . for producing or using atomic energy". At a first reading this may be interpreted as a reference to the large plants used for the military and industrial applications of atomic energy. No man of science could claim the privilege of spreading information about such plants at will, much as we look forward to a time when world confidence will have been restored to a level at which these matters need no longer be regarded as secret.

However, a closer study of the Act, and in particular of the definitions in Clause 18, reveals that "plant" includes "any machinery, equipment or appliance", and that "atomic energy" is defined in a way which covers any process in which atomic nuclei give up energy. Natural radioactivity is excluded, but the provisions of the Act include artificial radioactivity. Moreover, any reference to the production of atomic energy also applies to any process "preparatory or ancillary to such production. . . ."

It has been pointed out that, on the basis of these definitions, a cyclotron, for example, would be a plant for the production of atomic energy. Indeed, it is likely that a scientific investigator who talks to another about a new feature of cyclotron design, or who writes a paper on that subject, or any journal which publishes his paper, is committing an offence under the Act. In order to remedy this, the Minister undertook "to make an order, at once on the passage of the Bill, freeing . . . the ordinary tools of the nuclear physicist's trade". Once this order is made, the most flagrant divergence between the law and the normal working practice of the man of science will have been removed.

There are, however, many other ways in which the normal practice of the scientific worker may bring him into conflict with these very sweeping and vague definitions. The question of the results of measurements with a cyclotron (as opposed to its construction or method of operation) was raised in the debate in the House of Commons, but the Minister was unable to give an assurance on it. Legally it seems that Rutherford's experiment on the disintegration of nitrogen, if done to-day, would be subject to the Act as a "plant for the production of atomic energy". Such difficulties arise over a wide field, since the inclusion of ancillary processes presumably covers, for example, plants for the separation of isotopes. Any idea in this field may be regarded as representing a "proposed plant", and hence could not be discussed with anybody without the consent of the Minister.

The Act directs the Minister not to withhold consent if the information is not important for the purposes of defence; but this is surely not a very effective safeguard. Even if scientific men could be sure of getting permission to publish on application, the need to apply for such permission frequently—and not only in matters of clear military importance—would stifle free and informal discussion, and rapid publication, two of the essentials of scientific progress. In fact, most scientific workers would probably fail to understand the legal technicalities, and will continue to let common sense be their guide, even where this may mean that technically they are breaking the law. The Minister will have to weigh the bad practice of encouraging them to ignore the law against the risk of an irresponsible person making reckless disclosures.

Under the Official Secrets Act, a scientific worker undertakes not to disclose information about research on certain specified matters—and usually such activities are those carried on in Government establishments—to which he has been given access in the full knowledge of what is involved. Under Clause 11 of the new Act, however, all men of science may break the law if they communicate information, however acquired, in a much wider field; and it will be difficult for the individual to know where the line is to be drawn. Even if most of the parts of physics investigated in university laboratories are exempted by order of the Minister, a legal right is now lost to science, and free publication has now become a matter which can only be undertaken with permission, instead of by right.

If it is intended that most university research shall be exempted from the working of the clause, then the purpose of the Act must be to cover eventualities outside the scope of the Official Secrets Act. Perhaps it could be used if a new discovery of great military importance were made in a university laboratory; it could be used to ensure that further work on this subject should be carried out under conditions of secrecy. This would probably mean, except in war-time, that the work would have to be carried out in a Government establishment. No objection can be raised to the use of the Act in this way.

It would be more serious if the Act were used to allow the representatives of the Minister to examine the results of each piece of research in nuclear physics before publication. We hope this is not the intention of the Minister. A censorship of this kind would be possible only if research workers from foreign countries were excluded from university laboratories where nuclear work was in progress, and the undergraduate students, too, were denied any intimate knowledge of the research work going on in departments where they are studying. The loss this would involve to the vitality of scientific life in Great Britain would, from the point of view of work of potential military value alone, far outweigh any loss through leakage of information.

It is possible also that the Act as it stands might be used to prosecute men of science, not working in Government establishments and not bound by the Official Secrets Act, who deliberately disclose to the agents of a foreign Power secret information about atomic energy plants, acquired in one of the many ways which are possible to anyone actively working on nuclear physics. Leakage of information in this way must, of course, be prevented. But the price now being asked for this precaution is too high. In any prosecution brought before the courts under the Act, the defendant would obviously plead that he did not know that the information was secret, and that he had done nothing but discuss a matter of scientific interest with a colleague. A successful prosecution in such a case would immediately discourage even *bona fide* discussion. It needs little imagination to see what that would mean for nuclear physics, or indeed any other branch of scientific investigation. We should lose the chance that we now have of regaining our lead in the subject, and the chance that we shall have information worth 'giving away' will become small.

A very grave responsibility therefore rests with the Minister so to frame his orders for exemption that genuine discussion is not impeded. He must also make it clear that his very wide powers are to be used in an emergency only. Until the necessary orders are issued, there will be a cloud of doubt overhanging all teaching and discussion in the field of nuclear physics. It is to be hoped, therefore, that there will be no unnecessary delay in defining clearly and unambiguously the particular matters which, in the opinion of the Minister of Supply and his advisers, must come within the scope of the Act.

THE METAMORPHOSIS OF PLANTS

Goethe's Botany

The Metamorphosis of Plants (1790) and Tobler's Ode to Nature (1782). By Agnes Arber. Chronica Botanica, Vol. 10, No. 2. Pp. 63–126+pl. 23–26. (Waltham, Mass: Chronica Botanica Co.; London: Wm. Dawson and Sons, 1946.) 2 dollars.

GOETHE'S essay on "The Metamorphosis of Plants", first published in 1790, provides a theme of recurrent interest. Yet it would probably be not untrue to say that while the majority of contemporary botanists are familiar, in a general way, with the underlying idea of this work, few have studied the original edition or had access to the English translations. Indeed, the latter are not readily accessible to the ordinary reader. By preparing a new and critical translation, Dr. Arber has rendered a signal service to botanists. But more than that, she has rendered a service to botany, for the translation is preceded by an introduction which is a model of its kind. To those who have occupied themselves with the history of botany, particularly that relating to the last two hundred years, the introduction will indeed prove all too short. For the author has much to say that is interesting and important about the genesis and development of Goethe's idea, its intrinsic merit, its place in botanical science and, more generally, in the philosophy of biology. The aphoristic terseness and sureness of touch with which these matters are set out make it difficult to do more than emphasize the value of the new translation and introductory essay.

Students of plant morphology are familiar with the general idea underlying Goethe's theory of metamorphosis, namely, that all the external parts of the shoot are regarded as being due to the transformation of a single organ, that organ—an ideal leaf—being itself an abstraction. Or, in the words of the new translation . . . "the laws of transmutation according to which she (Nature) produces one part from another, and sets before us the most varied forms through modification of a single organ . . . the process by which one and the same organ presents itself to our eyes under protean forms, has been called the *Metamorphosis of Plants*". Contrary to a view widely held, Goethe was apparently not acquainted with the earlier related work of Kaspar Wolff ("Teoria Generationis") published in 1759, when he wrote the "Metamorphose". The view now before us is that he was an independent observer, a philosopher who looked closely at plants, and who was imbued with the idea of developing some general conception, or nexus of ideas, to cover the diversity of form which he saw everywhere in Nature, as well as in the individual plant. His method of presenting his views was not that of the man of science, but, as Dr. Arber points out, essentially that of a man of letters. The ideas in the "Metamorphose", which are set out in an easy, familiar and somewhat tentative fashion, on close examination prove to be rather elusive. Here Dr. Arber supports other critics in the view that the difficulty of grasping Goethe's ideas of metamorphosis is largely due to the fact that he did not always succeed in grasping them firmly himself. Nevertheless, that he was preoccupied with morphological developments of a most important kind cannot be denied; moreover, he was interested in the underlying mechanism, he tried to formulate general ideas admitting of synthesis; and he produced an essay, which if not good science, still provokes thought. There is, of course, always a danger of reading into a work of this kind considerably more than the author intended. Nevertheless, after reading some passages in the "Metamorphose", it is interesting, if idle, to speculate on the contribution which Goethe might have made to biological theory had he been alive to-day.

Dr. Arber has not only concerned herself with the text of the "Metamorphose": she has also made use of much additional matter from Goethe's correspondence and the comments of his contemporaries. Hence she has been able to present as critical an estimate of his contribution to botany as we are likely to get. Thus she emphasizes that Goethe's great service to morphology—we owe the word to him—was his recognition that its basis must be essentially comparative. On the difficult question of Goethe's scientific status, she remarks that . . . "This question still remains fraught with difficulty, for the catholicity of his mind, and the kaleidoscopic character of his activity, defy neat labelling. As a botanist, he began with a simple utilitarian interest in plants; he passed through a brief period in which he studied the multiplicity of the plant world from the standpoint of the descriptive naturalist; this was succeeded by a phase in which his mind was entirely possessed by comparative morphology, a subject to which the value of his contribution, and the inspiration which later workers have derived from it, are undeniable; and, finally, by a transition natural to his mental growth, he reached a stage in which his morphological thought reached out to the reconciliation of the antithesis between the senses and the intellect, an antithesis with which traditional science does not attempt to cope. It has been suggested by a literary critic that Goethe was 'a great poet who grew out of poetry'. Approaching him, as we have done here, through the medium of his plant studies, we may perhaps offer the comparable conclusion that Goethe was a great biologist, who, in the long run, overstepped the bounds of science."

The publication under review also contains the original and a translation of the rhapsody on Nature, attributed to Goethe—"Nature: Aphoristic"—a translation of which by T. H. Huxley opened the first issue of *Nature* in 1869.

By this new work of scholarship, Dr. Arber has again placed a wide circle of botanists in her debt.

C. W. WARDLAW

HISTORY OF BRITISH SCENERY

Britain's Structure and Scenery

By Prof. L. Dudley Stamp. (The New Naturalist Series.) Pp. xvi+255+64 plates. (London: Wm. Collins, Sons and Co., Ltd., 1946.) 16*s*. net.

IT is gratifying that the editors of the New Naturalist series have taken a wide view of their province, and have provided a volume which presents "a general view of the stage and setting of Britain's Natural History". With the growing interest in ecological studies, naturalists require to be increasingly aware of the physical background, of the fundamental differences between the various British regions, and of the factors which lead to their modification. These considerations apart, however, geology is a branch of natural history, appealing to a band of amateurs whose numbers are once more increasing, and this well-illustrated introduction to some aspects of the subject is therefore doubly welcome.

The author, Prof. L. Dudley Stamp, has not been content to provide a work which will merely meet the needs of the ecologist, but has adopted a broad interpretation of his subject; indeed, much besides the structure and scenery of Britain is dealt with in this book. He describes the chief surface features and also indicates the long and complex series of events which have determined their present form and distribution. He has, in short, attempted "to compress a large section of the science of geology" into a single volume.

After four introductory chapters (thirty-six pages) there are seven short chapters on general physiography (the work of rivers and of the sea, the scenery of sedimentary rocks and of glaciation, etc.). Then follow three chapters (sixty-nine pages) on the geological history of Britain, and ten chapters (sixty-nine pages) on the various regions of Britain. In the latter, chief emphasis is laid on south-eastern England. London and Hampshire basins and the Weald get more than twenty pages, while Wales (including the Welsh borders) and the North of England (including the Lake District and Pennines) each have less than five pages. The author, faced with such a task, must have found great difficulty in allocating his space, and one can only wish that the book had been extended to allow a more adequate treatment of these regions, for this section will surely be the one most frequently consulted, both by the amateur naturalist and by the intelligent reader with a general interest in the countryside.

Faced with a choice between such a reduction of this part of the volume or of some earlier section, many would have preferred a shorter treatment of the historical and stratigraphical section. It is true, however, that an account of geological history provides a basis for summarizing the distribution of rock types, and that no constructive geological thinking is possible except in terms of a time-scale; some knowledge of geo-chronology is almost essential as a basis for the interpretation of scenery.

In this historical section the author has freely used diagrammatic palæogeographical maps; there are some twenty of these—more than a quarter of the text-figures provided in the volume. He quite properly indicates that many of these are based on inadequate information; but it may be wondered if he sufficiently emphasizes the fact that each map gives a synopsis of the conditions during a considerable interval of time. For example, the map showing the geography of Millstone Grit times (Fig. 44), based on the well-known diagram by the late Prof. Gilligan, may puzzle many readers, with its river flowing across the sea for some three hundred miles, joined on its way by various tributaries before finally building its delta as it reaches St. George's Land.

To condense so much information for a reader with no previous knowledge may lead an author into generalizations which would not be accepted without qualification by his colleagues; but it is unfair to criticize him on this account. In order to avoid technical terms he may find himself driven to rather inexact statements. There are, however, some misleading sentences in this book which it may be possible, without adding to the reader's difficulties, to correct in a new edition. For example, it is incorrect to speak of the "corrosive" power of ice (p. 83), or, in its context, of "submarine" denudation (p. 81). Eustatic movement is not merely the gentle elevation or depression of blocks of the earth's crust relative to sea-level (p. 22), and if no greater precision is needed, the term eustatic would be better omitted altogether. The ordinary reader may find difficulty in understanding the map (Fig. 1) illustrating Highland and Lowland Britain (apparently showing the areas occupied by older and newer rocks) when he realizes that the mountainous isles of Mull, Skye and Arran are counted as lowlands, and the lowlands of Scotland are reckoned as highlands.

It is probably unnecessary to say that the volume is beautifully produced in the style which we have been led to expect in this series, and many of the illustrations are excellent. The colour photographs are well reproduced, and apart from the features they illustrate, many of them are very attractive as pictures. The author in some cases has provided a diagram showing the structures represented, a valuable feature which might have been extended. Perhaps the most useful plates are those based on oblique air-photographs, which are particularly successful as demonstrations of geological structure. There are a good index and a short annotated bibliography.

A. E. TRUEMAN

PURIFICATION OF TEXTILE FIBRES

An Introduction to Textile Bleaching

By J. T. Marsh. Pp. xiii+512+32 plates. (London: Chapman and Hall, Ltd., 1946.) 32*s*. net.

THE bleaching of textile materials is undoubtedly an ancient art, the origins of which are lost in the mists of antiquity. Like other such arts, it was for many centuries based simply on traditional and empirical knowledge. As the author of the present volume, speaking of the state of textile bleaching prior to 1914, states in his preface, "The purification of textile materials, scouring and bleaching, followed a characteristic routine in which secret recipes were handed down from father to son, surrounded by such an aura of mystery that it was impossible to approach the subject on a rational basis". The purpose of the present work is to set forth the rational basis on which the new science, as distinct from the old art, of bleaching must rest, in the light of the new knowledge which the past two decades of intensive research on textile fibres have revealed.

The actual bleaching of textile yarns and fabrics is only one of numerous processes having the common aim of producing an æsthetically satisfactory material for use or ornament; from the strictly utilitarian point of view the vast majority of fabrics would give better service were bleaching omitted. In this sense bleaching is to be regarded as a necessary evil, and the aim of the bleacher is to produce the necessary improvement in appearance with the minimum of damage to serviceability. To this end, bleaching processes, many of which are severe in character, have to be carefully controlled, and such control is possible only when the chemical constitution and physical properties of the particular material are thoroughly known and appreciated. The author, therefore, very properly opens his treatise with a fairly comprehensive description of the nature, chemical structure and physical properties of the main types of natural fibres, and, in less detail, those of the older and newer synthetic fibres or rayons. In parenthesis it may be stated that the total available volume of information on rayon is small compared with that relating to the natural fibres: the section in the present work dealing with the bleaching of rayon, for example, occupies only two pages; the author cannot be held responsible, however, for the fact that while much research on rayon has been carried out, little has been published.

Having thus laid a very necessary foundation, the author proceeds to describe the purification processes preliminary to bleaching proper. In some cases, for example that of wool in many of its applications, these are, in fact, more important than the bleaching processes themselves, and upon their proper execution the success or failure of the latter generally rests. Hence it is not really surprising that the actual subject of bleaching is not reached until the author has run one third of his appointed course. Then, however, the matter is dealt with very faithfully, and the various types of bleach, as applied on one hand to cellulosic fibres, natural and synthetic, and on the other to the protein fibres and their artificial counterparts, are described, examined, and criticized in considerable detail.

Finally, and since bleaching really is a necessary evil, logically, a section is appended in which the various types of damage which can be inflicted upon textile fibres by unskilful processing are dealt with, and the methods in general use for assessing such damage are described.

The author in one or two instances perpetuates errors of fact, such as, for example, that nylon does not swell in water, and that wool fibres become brittle when completely degreased; but these are minor defects in a work which will undoubtedly prove of great service both to those actively engaged in the industry, and to those students to whom the industry must look for its future technologists. The treatment is strictly scientific throughout, and free from any suggestion of empiricism, and the text is liberally supplied with references to the literature. One might have wished, perhaps, that in some instances, where the literature presents an ambiguous or even contradictory picture, a more critical attitude had been adopted in this respect; for it is precisely in such cases that the non-expert reader is entitled to expect from the expert author guidance as to the reliability or otherwise of published work.

This volume is, nevertheless, a useful successor to the recently revised "Introduction to the Chemistry of Cellulose" by the same author and F. C. Wood, and should find a place on the shelves of all who are interested in the science of textile materials and processes. N. H. CHAMBERLAIN

AN X-RAY ENCYCLOPÆDIA

X-Rays in Practice

By Dr. Wayne T. Sproull. Pp. vii+615. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 30*s*.

THE description of this book as an encyclopædia is scarcely an exaggeration. To quote from the dust cover . . . "the book deals with the generation, absorption, scattering and diffraction of X-rays; measurement and recording of X-rays; X-ray equipment; industrial radiography; medical application; X-ray diffraction and crystallography; fluoroscopy, automatic inspection, microradiography, gem coloration, etc.". There are also some nuclear physics and electron diffraction, and it is indeed difficult to think of any other subject that might have been included.

But this method of treating the subject raises an important question: Ought one man to write an encyclopædia? One man cannot be expected to be so expert on all the branches of a subject that he can present them to others, and this defect is apparent in certain portions of this book; Dr. Sproull has failed in several instances to convey an adequate idea of the present state of knowledge or of practice. For example, the section on X-ray tubes is very detailed, far more detailed than any other book of which the reviewer is aware, and on that account extremely valuable. But it omits entirely any reference to commercially made demountable tubes, and gives the impression that a supply of sealed-off tubes will fulfil the needs of any laboratory. This is not the general experience in Great Britain, where tubes with interchangeable targets are very popular; it would, for example, not be economical to make sealed-off tubes with manganese or zinc targets.

The weakest part of the book, however, is that on X-ray diffraction. Here Dr. Sproull is obviously out of touch with modern developments, and gives the reader an outline which is of little practical use. For example, he describes W. L. Bragg's method of determining the structures of NaCl and KCl. The historic importance of this work is unquestioned, but crystal structures are not worked out that way nowadays.

There are still more serious defects than this, however; these are illustrated by the following direct quotations:

"The only system (of space-group nomenclature) that nearly everybody understands is the Schonflies system" (p. 311). (The Mauguin system is mentioned, but an error is made in the accompanying example.)

"At ordinary temperatures one may regard f and f_0 (the atomic scattering factors at room temperature and at absolute zero respectively) as practically identical" (p. 357).

"Although the Laue method is the oldest method of crystal analysis it is still used by some of the foremost crystal analysts" (p. 371).

There may be a grain of truth in each of these statements, but the cumulative effect must be to give a quite misleading impression to the beginner.

Dr. Sproull has also introduced some rather unusual terms. Outstanding is the word 'suppression', used in connexion with the systematic *absence* of reflexions due to space-group symmetry. Buerger recently, and apparently quite unnecessarily, introduced the term 'extinction', which is unfortunate, since it already has a definite meaning in X-ray analysis. But in the reaction from this, is it necessary to introduce still another term? Similarly, the term 'crystal lattice' (p. 302) is used to describe what is already known as 'crystal structure'. It is a merit of the book that there are few loose statements, and it is perhaps this that makes such defects stand out; many writers use the word 'lattice' without a clear statement of the meaning they attach to it, and Dr. Sproull certainly does not do this. But why not leave the word 'lattice' to fulfil its ordinary and quite proper function?

It will be seen that most of this criticism of the book applies to the sections on X-ray diffraction; the sections on apparatus and industrial applications are much more satisfying. Nevertheless, even in these sections some elementary mistakes have crept in. The author speaks of "absorption per c.c." (p. 72), and on p. 100 he gives the impression that an angle is greater than 90° if its sine is greater than unity.

On p. 449 the same symbol is used for two different meanings in the same equation, so that the following monstrosity occurs:

$$2d\theta = -\frac{2\,dd}{d}\,\frac{\sin\theta}{\cos\theta}.$$

The difficulty of nomenclature in differentiating Bragg's equation because of the presence of *d* is well known; but a judicious use of δ's would have solved the problem.

Apart from the universality of its scope, the book also attempts to cater for too wide a range of reader. Many parts of the book require a fair knowledge of physics and mathematics; yet flat-irons and base-ball, pistols and bullets, continually obtrude themselves. It can fairly be said that one to whom such analogies appeal could derive little benefit from the rest of the book; and those who find the book at their own level must be irritated by these sudden intrusions.

To summarize, then, one might say that this would have been a much better book had its scope been less. On the technicalities of X-rays it is good, and the large number of references to original work should make it extremely useful. But those sections with which the author is presumably unfamiliar should have been omitted.

H. LIPSON

ORGANISATION OF AGRICULTURE

Farming and Mechanised Agriculture

Edited by Sir R. George Stapledon. Pp. 492. (London and New York: Todd Publishing Co. Ltd., 1946.) 21*s*. net.

THIS annual reference book, now in its third edition, provides a conspectus of the organisation of agriculture in the United Kingdom. Farmers are well aware, perhaps painfully aware, of the complexity of this organisation; but the reader who has no professional contact with agriculture may well be surprised at the number of official and private bodies which exist to control or develop different parts of the industry. Ten Ministries or Departments, and twenty-eight statutory bodies with numerous committees, the work of which is concerned in varying degree with agriculture, are listed in addition to thirty-five national societies or associations and many local ones. According to the point of view of the reader, these figures may be taken as a striking illustration of the size and importance of the agricultural industry, and the diversity of its products, or as an example of the insidious growth of bureaucracy.

The book begins with a series of articles covering a wide field, ranging from the world supply of food and timber to the chemical control of weeds. The purpose of this section is not clear from its contents; if it was intended to present a comprehensive view of the present state and current problems of agriculture, the selection of subjects is not a well-balanced one; for example, two of the articles, by members of the same branch of the U.S. Department of Agriculture, deal with closely related topics. This section is likely to be of more interest to the general reader than to the agriculturist, for the subjects have been fully discussed in many recent articles in the technical Press, and in books, in some cases by the same authors. It is followed by a short section on legislation and policy.

The middle section consists of directories of the official bodies concerned with agricultural administration, including some in the Dominions and the United States, statements of the objects and policy of these bodies and of private organisations and officially appointed committees, an account of the organisation of agricultural education, a directory of educational and research institutions and a directory of organisations interested in farming and mechanized agriculture. This is perhaps the most useful part of the book, for the information which it contains is not all available in any other single publication. Some small changes in arrangement might make consultation easier; for example, the laboratories directly controlled by the Ministry of Agriculture, the Department of Scientific and Industrial Research and the Agricultural Research Council are not included in the directory of research institutions but appear earlier, in the official directories.

Later sections give tables of statistics of agricultural production, a list of books, periodicals and films on agricultural subjects, a "Who's Who in Farming and Mechanised Agriculture", and a subject index. There are a number of obvious omissions from the "Who's Who", as well as some scarcely justifiable inclusions, and in future editions it would be preferable to replace this section by an index of names referred to earlier in the text.

Two general criticisms may be made: first, the title is misleading, for the book contains little information on the practice of husbandry, and still less on mechanization; secondly, the book is unnecessarily well made and the price too high for an ephemeral work which is to be renewed annually.

D. J. WATSON

THE STORY OF LEATHER

Leather in Life, Art and Industry

Being an Outline of its Preparation and Uses in Britain Yesterday and To-day, together with some Reflexions on its Place in the World of Synthetics To-morrow. By John W. Waterer. Pp. 320 + 111 plates. (London: Faber and Faber, Ltd, 1946.) 50*s*. net.

MR. WATERER has written a remarkable and a fascinating book. It should be read not only by all who have any connexion, however remote, with leather and leather goods, but also by all who take an interest in the social and industrial history of Great Britain. Mr. Waterer has a knowledge of his subject that only first-hand experience can give, and, more than this, he writes with the fervour that springs from advocating a worth-while cause, namely, that in these days of factory production a study of industrial design can ensure that meetness of material, form and purpose which existed in the days of the old craftsman who carried through the making of an object from start to finish with his own hands and brains.

The making of leather and leather goods is one of England's oldest industries, and one of the first to achieve the distinction of an export trade. Over the centuries the reputation of certain English leather goods was built up, so that even to-day things like English saddles and sports goods, certain classes of luggage, and men's shoes are still regarded as the best that can be made. This aiming at a high standard of quality was achieved in the early middle ages by the efforts of the trade guilds, of which about a dozen were connected with articles of leather, with six surviving to this day though no longer exercising supervision over the crafts they nominally represent.

About a third of Mr. Waterer's book is devoted to the leather guilds and crafts. The story of the guilds is not unamusing—founded to protect the interests of the members, all of whom were originally active participants in the crafts concerned, and to maintain a high standard of quality in the wares offered to the public, they soon allowed these high moral principles to give way to ordinary human nature, and we find them quarrelling with each other over spheres of influence (even to actual bloodshed), opposing the employment of foreign political refugees, and making a bid for the 'closed shop'—in fact, behaving in a manner quite familiar to us in 1946.

The next section of the book is devoted to a brief account of different classes of leather produced by modern factory methods, and to an enumeration of the many uses of leather in modern life. This will astonish most readers, for besides the obvious uses that are encountered in every individual's daily life there are also the many uses that leather finds in this mechanical age, namely, as essential parts in machines for spinning and weaving and as washers and cups in hydraulic machinery—for example, all the oil that is pumped up to the earth's surface passes over leather washers.

Finally, the book summarizes the facilities in Great Britain for education in modern methods and for the research which is so vitally needed to keep the age-old industry abreast of modern life.

The volume is beautifully produced and lavishly illustrated, and reflects great credit on both author and publishers. It is a pity that the general impoverishment of post-war England has necessitated a cloth binding—it is certainly worth one of those beautiful tooled leather bindings shown among the illustrations.

D. JORDAN LLOYD

PLANTS OF THE PACIFIC

Plant Life of the Pacific World

By Prof. Elmer D. Merrill. (Pacific World Series.) Pp. xv+295. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1946.) 16*s*. net.

THE vast area covered by the Pacific Ocean, combined with the range of climatic and physiographic conditions of the lands surrounding it and the islands it surrounds, inevitably results in a rich and varied plant life. The interesting and practical guide prepared by Prof. Merrill, however, covers only that portion of the Pacific, mainly the north-western tropical island groups, brought into prominence through the war against Japan. Even within this portion there are certainly in excess of 50,000 different species and 2,500 different genera of higher plants. From the Philippines alone some 9,500 species of vascular plants have been recorded. Wisely, in a work intended for the lay reader, it is the ecological and economic aspects of the plant life that are emphasized. The major physiognomic groupings are covered by chapters with headings such as plants of the seashore, the mangrove forest, the secondary forests and open grasslands, and the primary forest. Attention is also given to plants of special interest, to weeds, and to cultivated plants. A chapter of practical value deals with 'jungle foods'. The professional botanist will find much that is new to him in all these chapters, mainly because Prof. Merrill so often draws upon his own wide experience.

In two chapters, problems of plant distribution are especially considered for Malaysia and Polynesia respectively. Such disputed questions as the Wallace and Weber lines, the relationship and historic connexions between Malayan and Australian plants, and hypotheses concerning changes in physiography are considered very judiciously. The author is obviously opposed to accepting the Wegener hypothesis of continental drift in order to explain problems of distribution, and sums up his position in the words "Like some other theories, its acceptance would explain certain observed phenomena, but at the same time would leave unexplained another great mass of data that does not conform".

The Micronesian–Polynesian floras largely consist of the same general types as are characteristic of the Malaysian region, and this is true even of Hawaii. The floras of low islands are markedly different from those of high islands. The full explanation of when and how natural floras reached remote Pacific islands remains unknown. As the author says, "hypothetical land bridges have been scattered right and left all over the Pacific basin to explain the present-day distribution of this or that group of plants".

Particular attention should be directed to the well-selected bibliography, which will serve as a very adequate guide to the student seeking further information concerning the plant life of the far-flung lands of the Pacific Ocean.

W. B. TURRILL

STELLAR SPECTROPHOTOMETRY

Photometric Atlas of Stellar Spectra

By W. A. Hiltner and Robley C. Williams. Pp. iii+24+246 plates. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1946.) 42*s*. net.

A WARM welcome must be given to this first photometric atlas of stellar spectra, a useful reminder of the increased importance attached to the quantitative study of stellar radiation. Eight bright stars ranging from $B8$ to $M2$ have been photographed with the Coudé spectrograph of the 82-inch reflector of the McDonald Observatory, Texas University. The dispersion varies from 2 1 A. per mm. at 4000 A. to 14·2 A. per mm. at λ 6500 A. The spectra have been analysed at the University of Michigan with a null-type direct-intensity microphotometer. The resultant tracings with the intensity scale are reproduced for each star in a set of some sixty sections ranging from 20 A. at λ 4000 A. to 100 A. at 6600 A.; the magnification from spectrogram to published tracing is 21·6.

The stars selected are β Orionis, α Lyræ, α Canis Majoris, α Cygni, α Persei, α Canis Minoris, α Bootes and α Orionis. It is instructive to watch the changes in the tracings through the sequence for selected stretches of the spectra and to compare them with what one notices by examining the spectra directly with the eye. Such an exercise shows at once what seems the chief defect in the atlas, the failure to put a wave-length scale along the tracings, or alternatively to mask sufficient lines to make easier the identification of the weaker lines. Admittedly this would have been a heavy additional labour to the authors of the atlas, but it would have been a great help to those making use of it. A comparison made between the atlas for α Cygni and the table of wave-lengths given by Struve for spectrograms of the star secured with the same instrument (*Astrophys. J.*, **94**, 344; 1941) shows that the effect of the grain on the microphotometer has been somewhat disappointingly large, and that the weakest lines, of intensity 0, and many lines of intensity 1 are lost. Messrs. Hiltner and Robley Williams cannot be blamed for this, the trouble being inherent in the material available, and they are to be congratulated on having led the way in a new field and having produced a work of considerable usefulness to their fellow-workers.

F. J. M. STRATTON

He Conquered Death

The Story of Frederick Grant Banting. By Margaret Mason Shaw. Pp. xiii+111+11 plates. (Toronto: The Macmillan Co. of Canada, Ltd., 1946.) 8*s*. 6*d*. net.

INFORMING children of famous discoveries in science presents many difficulties, and the method of tracing the biography of the discoverer is probably likely to be most successful. With a man of such varied interests and lovable qualities as the late Sir Frederick Banting, the task of the biographer is made easy. Yet Miss Shaw, who worked under Banting for eleven years at the University of Toronto, must be commended for the skill with which she has kept faith with Banting's tenacity for truth and for the way in which she stimulates the imaginative faculties of the young readers for whom her book is intended. This she achieves by allowing Banting's life-story to be told by a practising doctor, who was a contemporary of Banting in his undergraduate days, to a group of interested boys. As the story unfolds they learn of the discovery which made Banting world-famous, the methods and attitudes of research workers in general, Banting's marked abilities as a painter and his friendship with A. Y. Jackson, his experiences in two world wars in military medicine, and other events and incidents which made up a full and varied life. Miss Shaw has written a moving account of the great Canadian man of science which should be bought for every juvenile library where English is read. T. H. HAWKINS

Survey of Askham Bog

By Bootham School. Pp. 75. (London: Bannisdale Press, 1946.) 8*s*. 6*d*.

IN 1879, three Bootham School masters, assisted by local naturalists, made a thorough survey of Askham Bog, near York. Their report was published in a magazine published for the Society of Friends Schools called the *Natural History Journal*. Recently this report was discovered by Mr. Clifford Smith, the present biology master at Bootham, who had the happy idea of making another survey of the same area. The present report is a record of the patient team-work of ninety Bootham boys under Mr. Smith's general direction.

The bog itself is a small piece of swampy ground about a mile and a quarter in total length and at no point more than a quarter of a mile broad. Much of the bog remains more or less as it was when the original survey was written; this adds greater significance to the recent investigation. Independent surveys were made into the geology, botany and zoology of the bog, and these were brought together in a general ecological report and summary. All these sections were recorded and reported by the boys themselves.

The value of the report lies not so much in the findings—although the discovery that the bog could not be fitted into any of the generally accepted ecological categories is of intrinsic importance—as in its educational worth. By giving boys experience in accurate observation, by teaching methodical recording of what they had seen, and by quickening the desire for further knowledge, this project has made a useful contribution to increasing the talents of the individuals concerned and to their harmonious development. It is noteworthy that several of the participants have already passed beyond the stage of being interested amateurs in natural history.

A Laboratory Manual of Qualitative Organic Analysis

By Dr. H. T. Openshaw. Pp. viii+95. (Cambridge: At the University Press, 1946.) 6*s*. net.

ALTHOUGH there are already many books which deal with this subject, it is usually only a part of the whole, and a small volume devoted entirely to organic identification is a welcome addition. This work is written for students, is based on the author's many years teaching experience, and has been thoroughly tested in practice. The first part describes a series of tests for the more characteristic groups commonly encountered in organic compounds, but the larger part deals with the final identification of an organic substance by the preparation of a suitable derivative, the melting point of which (and mixed melting point) can be determined: in this part directions are given for the preparation of each derivative, and indications as to which is likely to prove suitable for the purpose in view in any particular case. Tables of melting points of various derivatives of all the commoner organic compounds which might be met by the student are given, and these are sufficiently complete to make them of value to research workers. The book can be confidently recommended to all those studying or teaching organic chemistry. F. B. KIPPING

Practical Chemistry

For Medical Students. By William Klyne. Pp. xvi+460. (Edinburgh: E. and S. Livingstone, Ltd., 1946.) 20*s*. net.

THIS volume is a product of the experience gained in teaching medical students in the University of Edinburgh and deals with practical chemistry for such students from A to Z. General scientific method is first discussed in a manner which should go far to explaining to the dullest student exactly why he is performing an experiment, and indeed why experiments are ever performed. There follows a general account of practical methods such as heating and cooling, production of reduced pressures, crystallization, weighing, etc., in fact all those operations which must first be mastered by a student. The later parts of the book deal with general and physical chemistry, inorganic chemistry and organic chemistry systematically, all treated from the point of view of the medical student. Throughout, great stress is laid on the methods of recording experimental results and of note-taking—topics on which most students are lamentably ignorant. Altogether the work seems to accomplish what it sets out to do in a very efficient manner.

The Cathode Ray Oscillograph in Industry

By Dr. W. Wilson. Second edition revised. Pp. xii+244. (London: Chapman and Hall, Ltd., 1946.) 18*s*. net.

THIS excellent technological book on the industrial applications of the cathode ray oscillograph has been considerably enlarged in this second edition by the author, particularly by the incorporation of new photographs, for one of which a magnification of 200,000 is claimed. The author excludes television tubes, but includes full descriptions of straight and pumped cathode ray tubes and varieties of the electron microscope, all of which in many forms have proved themselves key tools in recent scientific progress in industry. L. E. C. HUGHES

ORGANIC CHEMISTRY: PHYSICAL METHODS AND BIOLOGICAL RELATIONSHIPS*

By SIR ROBERT ROBINSON, PRES.R.S.

THE future historian of science will certainly characterize the first half of the twentieth century as an age of unsurpassed progress of discovery in physics. He will also note the *crescendo* in the elaboration of physical techniques and the decisive part they played in the dramatic developments of the sister sciences. Examples are the commonplaces of our scientific practice, and could be culled from almost any active region of investigation. That almost self-evident fact is well illustrated by the record of the Royal Society's medallists of 1946, and I invite reflexion on the extent to which their distinguished experimental contributions have been rendered possible by a quick appreciation of the potentialities of new physical methods. The thermionic valve, the photo-electric cell, high-vacuum technique, high-pressure technique, production and management of very low and very high temperatures, X-rays, and the use of isotopic and radioactive tracers, are but a few of the tools which modern physics has placed at our disposal.

The vastness of the subject is very significant, and even if, as is necessary, I confine myself to organic chemistry, only a small part of it can be mentioned.

The forty years of my own experience have seen a revolution in the methods of experiment, and unquestionably the great waves of advance are clearly identified with the introduction of new techniques. The improvement of balances and the pioneering work of Pregl brought in microanalysis and, following in its wake, microchemical manipulation. It is safe to say that this has increased the output of a given laboratory man-power by at least 100 per cent because of the saving of time and energy expended previously on pure routine. But even more important is the fact that microchemistry has made possible the successful attack of problems, especially in the field of biochemistry, which could not even be attempted thirty years ago.

Many of the more spectacular researches concerned substances of high biological activity, and a vital part was played by the co-operation of botanists, zoologists, physiologists and bacteriologists. But equally necessary was the help of physicists in the provision of methods of investigation of 1–2 mgm. of material.

Among the more valuable of these new resources are ultra-violet and infra-red spectroscopy and X-ray crystal analysis. The triumphs of the latter are well known, and I will only add that the last details of the constitution of penicillin were revealed by the X-rays in the hands of Crowfoot and Rogers at Oxford and Bunn and Turner-Jones at Northwich. The laborious Fourier analysis which the complete mapping of electronic densities still demands will soon be carried out by machines, and it is not at all improbable that molecular structures will eventually be ascertained with ease, and almost by inspection. That will not close the organic chemical and biochemical laboratories, but, on the contrary, will give impetus to their work in many fascinating directions.

* From the presidential address to the Royal Society delivered on November 30.

Ultra-violet spectroscopy, once the concern of specialists, is now practised universally; for many purposes, however, the study of infra-red absorption promises even greater usefulness.

Although subject to constitutive influences, the bands in the infra-red are far less so than those in the ultra-violet, and the method provides a kind of elementary analysis of the simpler groups contained in the molecule. It has been used *inter alia* to follow the course of polymerization, for the analysis and characterization of hydrocarbons, such as the isomeric octanes or butanes, and in the everyday control of industrial processes.

We were very impressed by, and grateful for, a recent demonstration of the power of infra-red spectroscopic analysis. A crucial test was devised in order to establish a detail of the constitution of strychnine, and the outcome depended on the unequivocal identification of a degradation product obtained in very small quantity. Our own work indicated that it was carbazole mixed with one of the four C-methylcarbazoles, and probably with 3-methylcarbazole. But we could not be quite certain. Mr Pausacker made the four methylcarbazoles, of which one was new, and Mr. Richards kindly studied their infra-red spectra. They were characteristic and differed also from that of carbazole. Using only 1·5 mgm. and a novel technique, Richards showed conclusively that the specimen was essentially carbazole containing about 10 per cent of 3-methylcarbazole. The probable course of events recalls the stages through which mountains have been said to pass—an inaccessible peak, an interesting course for experts, an easy day for a lady.

In many directions there have been notable advances in the processes of purification and analysis, but I will merely mention in passing the so-called molecular still, the ultra-centrifuge, polarography and electrophoresis.

I would, however, like to direct attention to a recent series of researches which foreshadow a leap forward in our knowledge of the proteins, again because of the introduction of a new technique. In doing this, I hope to make some amends for having recently bemoaned in another place the relatively small contribution of British men of science to protein research. The equipment for those who venture to follow the pioneers is not elaborate. I gather that the chief requirements are a lead tray, an earthenware drain-pipe and a sheet of paper.

Although the use of animal charcoal for the removal of coloured impurities from solutions has a respectable antiquity, and the separation of dyes in solution on filter paper has long been employed as a method of analysis, modern chromatography was introduced by Tswett forty years ago. He showed that coloured substances are selectively adsorbed from suitable solutions and that distinct bands are formed in a vertical column when the solution of a mixture is poured in at the top and allowed to fall through the adsorbant. In this way Tswett showed that leaf-green chlorophyll consists of two substances, later investigated by Willstätter and Stoll.

The many developments have included various devices for applying the method to colourless substances. A coloured group may be added to the molecule, the fluorescence of the bands may be observed instead of the colour, the adsorbant may be pre-coated with a fluorescent substance (Brockmann), or the column may be streaked with a reagent to produce a visible effect.

Chromatography is now a standard laboratory procedure, and in Great Britain Sir Ian Heilbron was the first to perceive its advantages.

Another well-known method of separation of substances depends on their partition between immiscible or partially immiscible solvents, and an apparatus for carrying out a large number of successive partitions has been devised by L. C. Craig at the Rockefeller Institute for Medical Research.

A still more ingenious idea is that of the partition chromatography which A. J. P. Martin and R. L. M. Synge (1941) worked out in the laboratories of the Wool Industries Research Association. It makes use of a Tswett column but is based on the principle of partition rather than on that of adsorption. This distinction is evidently valid in reference to the phases concerned, but it is not so certain that the two processes are not basically similar at the molecular level. As one example, particles of silica gel can be impregnated with a buffer solution on the alkaline side and placed in a column through which the substances to be separated, dissolved in a suitable immiscible solvent, are passed. The effect is obviously that of a large number of successive extractions, and bands analogous to those of a chromatogram are produced; the order of the bands from top to bottom will be one of decreasing acidity of the components of the mixture. *Ceteris paribus*, the most acid constituent, will be found in the top layer. This technique has been found to be well adapted for the separation of the penicillins on the laboratory scale. In 1944, Martin, in collaboration with R. Consden and A. H. Gordon, made a further step forward by the use of water-saturated cellulose as the stationary phase and a mobile phase consisting of a solvent such as phenol or collidine, partially miscible with water. Gordon, Martin and Synge had already shown in 1943 that strips of filter paper could be used to separate amino-acids, and the later work is an extension of this observation for the same purpose. The development may be one-dimensional or, preferably, two-dimensional, in which procedure the first solvent is removed by drying and a second solvent is allowed to ascend the paper at right angles to the direction taken by the first. A drop of protein hydrolysate suffices, and its constituent amino-acids become segregated in definite areas the position of which is dependent on the nature of the amino-acid and the solvents used. The well-known colour reaction with ninhydrin is used to show up the spots. Thus a rapid qualitative analysis of protein *bausteine* is achieved and, moreover, the presence of a new amino-acid will be indicated and a rough idea of its constitution will perhaps be obtained. Furthermore, the simpler peptides are separated and by subsequent hydrolysis and repartition their amino-acids can be recognized.

These researches will, I believe, be recognized as the greatest contribution to the study of the structure of the proteins made since the classical work of Emil Fischer.

How the method can be used is well shown by an outstanding investigation of the molecular structure of gramicidin-S by Consden, Gordon, Martin and Synge (1946). A partial hydrolysate was fractionated on two-dimensional paper chromatograms. The location of dipeptides and tripeptides having been determined, these were taken from a duplicate paper, hydrolysed, both before and after deamination, and the amino-acids identified by means of further chromatograms. The dipeptides so recognized were synthesized, and their behaviour on partition paper chromatography was found to be identical with that of the respective constituents of the partial hydrolysate. The method of ionophoresis was also used and the findings were consistent From the chain *ABCDE*, *AB*, *BC*, *CD*, *DE*, *ABC* and *DEA* were obtained and identified.

Hence, not only is the order of the five amino-acids established but also it is rendered very probable that the substance is a cyclic polypeptide. The crystallographic results of Crowfoot and Schmidt are compatible with the hypothesis that the ring contains ten amino-acid groups.

At the Liverpool meeting of the British Association for the Advancement of Science (Section B, 1923) I mooted the idea that many high molecular weight substances of repeating pattern type should be regarded as mammoth rings, basing this speculation mainly on the absence of end-groups required on the open-chain hypothesis. A cyclic decapeptide would include a ring of thirty members.

I will now refer to a subject pursued in my own laboratory in collaboration with biologists, namely, Dr. C E. Coulthard, of the Research Department of Boots Pure Drug Company, Ltd., and Dr. J. Ungar, of Glaxo Laboratories, Ltd.

The tubercle bacilli are characterized by the possession of a waxy envelope which has often been considered to confer some degree of immunity against the attack of chemotherapeutic agents. Consequently, it has been sought to endow the latter with fat-soluble groups in the hope of penetrating the supposed protective covering. Actually, it may be doubted whether this scheme, which has brought little success, is based on a sound conception, for it may be argued that all that could be achieved would be the establishment of a reservoir of the agent in the lipins. On these lines it would seem necessary to link the fatty part of the molecule to the water-soluble part, which it is hoped will attack the organism, by a readily hydrolysable linkage. Several variations of this theme can be envisaged. Be this as it may, it is obvious that the chemical nature of the lipins of the bacteria deserve close attention, and the first chemist to attack the problem, and with important results, was R. J. Anderson (1929 and later). The fatty acids obtained by hydrolysis of the waxes from the bacterial bodies were fractionated, and one of them, tuberculostearic acid, was found by Spielman, a colleague of Anderson, to be 10-methylstearic acid.

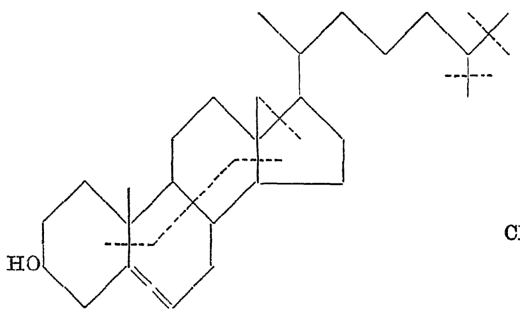
Important constituents of the mixture were acids of the formulæ $C_{26}H_{52}O_2$ and $C_{30}H_{60}O_2$; the former, termed *phthioic acid*, has been the more closely studied. Anderson was of the opinion that it was a branched-chain acid similar in constitution to tuberculostearic acid; but the evidence garnered by him and his collaborators and by Wagner-Jauregg was insufficient to establish the details.

E. Stenhagen and S. Stallberg then studied the behaviour of phthioic acid in monomolecular films and also the X-ray reflexions from barium phthioate. They came to the conclusion that the acid is ethyldecyldodecylacetic acid, or something very similar, but the synthesis of this substance by N. Polgar showed that this was an error probably due to the unusual degree of tilt of the molecules.

I will not burden you with the organic chemical details of Polgar's further work; but combined analytic and synthetic attack of the degradation products made it very probable that phthioic acid is 3 : 13 : 19-trimethyltricosanoic acid, a straight chain of twenty-three carbon atoms with three methyl branches. Phthioic acid is feebly optically active, but the optically inactive, synthetic 3 : 13 : 19-trimethyltricosanoic acid closely resembles phthioic acid in respect of its physical properties, including the behaviour of monomolecular films on water, and in the melting-points of its derivatives. We thus returned to the original general hypothesis of Anderson.

It has been known for some years that phthioic acid possesses toxic properties (F. Sabin, of the Rockefeller Institute for Medical Research, New York, and others) and that it produces lesions when suitably injected into experimental animals, for site structural features. A working hypothesis is that the methyl groups block β-oxidation, and some relation to physiologically active unsaturated substances may well be brought to light in the future.

An extremely interesting discovery, quite unrelated to this work in its origin, has been announced by R. P. Cook from the Biochemistry Laboratory, University of Cambridge. He has obtained an acid, or a mixture of acids, $C_{25}H_{50}O_2$, by feeding cholesterol to rats. This is very suggestive of an extraordinary process of unwinding of the tetracyclic nucleus of the sterinoid by breaks at the points where the rings are fused, and also at some peripheral point, and in the side-chain. For example, one possible degradation is illustrated below :



reduction and oxidation $\longrightarrow$

$CH_3(CH_2)_4.CHMe(CH_2)_{12}CHMe(CH_2)_3.CO_2H$

5 : 18-dimethyltricosanoic acid

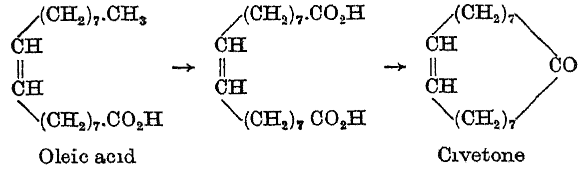
example, the guinea pig. But the observations of Coulthard and Ungar are new in that they have been able to reproduce, by a single intraperitoneal injection of synthetic acids of known constitution, a pathological picture which is almost identical with that of tuberculosis, in respect of the particular manifestations observed. There is no doubt whatever of the reality of the phenomenon, and it is highly significant.

The study of a range of synthetic branched long-chain fatty acids from this point of view is in its infancy, but the following results can be cited. The acids have been synthesized by N. Polgar, partly with the collaboration of S. David and E. Seijo. 3 : 12 : 15-Trimethyldocosanoic acid is even more active than phthioic acid, or synthetical 3 : 13 : 19-tricosanoic acid, which are equal within the limits of the method. On the other hand, 2 : 13 : 17 : 21-tetramethyldocosanoic acid is inactive. 13 : 17 : 21-Tricosanoic acid is inactive, and so is 2 :13-dimethylpentacosanoic acid. 13 : 16-Tricosanoic acid is active, but it was suspected that the specimen contained a 3-methyl-substituted impurity. A purified specimen exhibited greatly diminished activity. 4 : 13 : 16-Tricosanoic acid is very active, and though here again the presence of some 3-methyl substituent is not excluded, the activity is such that it can scarcely be due to an impurity. 3 : 13 : 19-$\Delta^{13:19}$-Tricosadienic acid is active but less so than the related saturated substance. It is probable that the specimen contains several geometrical isomerides. The syntheses are very laborious and the biological tests are prolonged, so that progress is necessarily slow.

At present it looks as if a methyl substituent in the 3- or 4-position is necessary. The biological property is evidently highly constitutive, but it is too early to attempt an identification of all the requi-

We are unable to equate the constitution of any substance that could be obtained in this way with that of phthioic acid, but such a direct relation was scarcely to be anticipated. If Cook's acid is really derived from the cholesterol molecule by some transformation, it must be a branched-chain acid, and the determination of its structure is a most urgent problem, the solution of which must surely shed some light on an aspect of the biochemistry of phthioic acid.

The temptation to carry speculation a little further cannot be resisted. In 1926, Prof. L. Ruzicka elucidated the constitution of civetone, the odoriferous principle of the civet cat, and made the dramatic discovery of the existence of large carbocyclic rings in Nature. He also noted the structural relation of civetone with oleic acid. Since the ketone has one less carbon atom than the acid and the latter is widely distributed, the degradation of oleic acid to civetone is more probable than the reverse synthesis. It may be suggested that oleic acid suffers ω-oxidation, a biochemical process to which Verkade has paid attention, and that this is followed by a familiar ketonization.



Oleic acid Civetone

But analogy then leads us to assume a similar mechanism for muscone from the musk-rat, which was also studied by Ruzicka. We find that its progenitor should be a 3-methylpalmitic acid,

$$\begin{array}{l} (CH_2)_{12}.CH_3 \\ | \\ CHMe\ CH_2\ CO_2H \end{array} \rightarrow \begin{array}{l} (CH_2)_{12}\ CO_2H \\ | \\ CHMe.CH_2\ CO_2H \end{array} \rightarrow \begin{array}{l} (CH_2)_{12}—CO \\ | \qquad\quad | \\ CHMe—CH_2 \end{array}$$

3-Methylpalmitic acid — Muscone

The occurrence of the 3-methyl-substituent is interesting in relation to phthioic acid. Further, Prof. Hans T. Clarke and his collaborators at Columbia University, New York, have shown by the use of C^{13} that the fatty acids are produced in the organism from acetic acid only. In parenthesis, this is a remarkable experimental justification of J. N. Collie's speculations on the role of keto-methylene chains in biosynthesis. An additional molecule of acetic acid could be used to introduce methyl substituents by the mechanism:

$$R.CO_2H + CH_3CO_2H \rightarrow R.CO.CH_2\ CO_2H \rightarrow R\ CO\ CH_3$$

$$R.CO\ CH_3 + CH_3.CO_2H \rightarrow R.CHMe.CH_2.CO_2H$$

3 : 13 : 19-Tricosanoic acid is not a possible product of this scheme of biosynthesis It would therefore not be surprising to find that phthioic acid, as at present known, is a mixture of a trimethyldocosanoic acid and a trimethyltetracosanoic acid. On this hypothesis the chain should in any event be even-numbered and the methyl groups can only be attached to the odd-numbered carbon atoms. The constitution proposed for tuberculostearic acid conforms to the first condition, but not to the second. It could, however, be 9-methylstearic acid, if oxidation occurs at carbon atoms 9 and 10 and is accompanied by a pinacol-pinacolone migration. Alternative views to that already mentioned involve the intervention of molecules of propionic acid or formaldehyde (or an equivalent) in order to provide the methyl substituents. These, however, fix the methyls on even-numbered carbon atoms and, though tuberculostearic acid then falls into line, they are at variance with our own deductions in regard to the constitution of phthioic acid.

Following the clue afforded by chaulmoogric and hydnocarpic acids in the treatment of leprosy, Roger Adams prepared a range of substituted fatty acids, some of which had considerable action on *B. lepræ* (or possibly an analogous organism) *in vitro*. The irritating action of these substances precluded their use in practice.

Our first efforts in the field of tubercle fatty acids had a similar objective, but we have now abandoned the idea of a frontal attack on the organism in favour of an attempt to alleviate the symptoms of the disease. If this can be achieved by an immunity method it is probable that the body resistance will be strengthened. That investigation has not gone beyond the planning stage, but we are glad to know that it will be in the capable hands of Prof. M. Stacey at the University of Birmingham.

There are indications that the pathological role of abnormal lipins may not be confined to tuberculosis. Thus Novak and Grey (1938) found tuberculous tissue, with lesions, associated with granulosa cell tumours, and suggests that these effects were due to lipins produced by the malignant growths. These observations have very recently been confirmed and extended in the United States.

ADAPTATION OF *STAPHYLOCOCCUS AUREUS* TO GROWTH IN THE PRESENCE OF CERTAIN ANTIBIOTICS

By Dr. E. P. ABRAHAM, D. CALLOW and K. GILLIVER

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IT has been noticed that certain antibiotics, when tested against *Staphylococcus aureus* (*H* strain, N.C.T.C. No. 6571) by the cylinder-plate method[1], give zones of inhibition which have clear edges, but which contain, scattered through them, small numbers of isolated colonies of *Staphylococci* (Fig. 1). Among the first antibiotics found to show this phenomenon was one obtained from an organism of the *subtilis* group (N.C.T.C. No. 7197) isolated from the soil at Oxford (referred to here as *S*) and one which Chain and Callow[2] discovered in extracts of *Polystictus versicolor* and have named polystictin (referred to here as *P*). Both are water-soluble substances which are not extracted at any *p*H by common organic solvents and which have only been partially purified. They do not appear to be identical with any of the antibiotics described in the literature.

The formation of isolated colonies in the presence of *S* and *P* involved two modifications of the *Staphylococcus* which were clearly distinct. This is shown in the three plates which are illustrated. Plate 1 (Fig. 1) was seeded with the normal strain of *Staphylococcus*. Plate 2 (Fig. 2) was seeded with a strain derived from the normal strain by picking off a colony from inside the inhibition zone caused by *P* on plate 1. When tested on plate 2, *P* was apparently inactive, whereas *S* produced a zone of inhibition similar to that which it gave on plate 1. Similarly, by starting with a colony from within the inhibition zone caused by *S* on plate 1, a plate could be prepared on which *P* produced a normal zone of inhibition but *S* gave no inhibition. Lastly, by picking

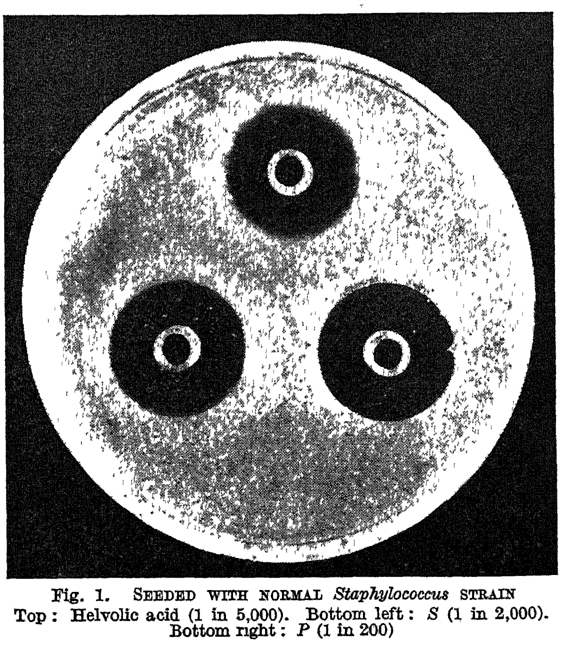

Fig. 1. SEEDED WITH NORMAL *Staphylococcus* STRAIN
Top: Helvolic acid (1 in 5,000). Bottom left: *S* (1 in 2,000). Bottom right: *P* (1 in 200)

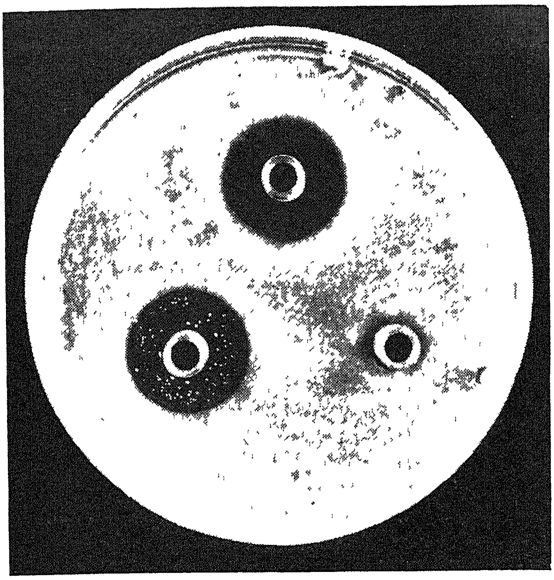

Fig. 2. SEEDED WITH *Staphylococcus* DERIVED FROM A COLONY RESISTANT TO *P* ON PLATE 1

Top: Helvolic acid (1 in 5,000) Bottom left: *S* (1 in 2,000) Bottom right: *P* (1 in 200)

off a colony from inside the inhibition zone produced by *S* on a plate seeded with *Staphylococci* insensitive to *P*, or by *P* on a plate seeded with *Staphylococci* insensitive to *S*, organisms were obtained which were insensitive to both *S* and *P* (Plate 3, Fig. 3). These insensitive strains of *Staphylococci* could be kept on agar slopes, or subcultured several times in a heart extract medium, without undergoing any noticeable reversion.

In view of the large number of antibiotics—in many cases still in an impure condition—which are being described in the literature, methods of distinguishing between these substances at an early stage of the investigations are of interest. Stansly[3] suggested that strains of organisms trained specifically to grow in the presence of different antibiotics could be used for this purpose. The procedure described here with *P* and *S* shows beyond doubt, in a very simple manner, that these two substances are different. It remains to be seen, however, how far the procedure can be extended to distinguish between other substances which give inhibition zones containing resistant colonies; the results of attempts to use the method to differentiate between antibiotics produced by certain members of the *subtilis* group have not so far been encouraging. One general limitation of the method is due to the fact that it is not known how far the resistance developed by an organism against a given antibacterial substance is specific. Organisms made resistant to one penicillin, for example, are found to have become resistant to other penicillins[4].

The majority of antibiotics investigated hitherto do not produce inhibition zones containing isolated resistant colonies on staphylococcal plates. Thus helvolic acid produces clear zones of inhibition on a plate seeded with the *Staphylococcus* even though the organism can be trained to grow well in the presence of this substance[5]. *Staphylococci* made resistant to *P* or *S*, or to both substances, showed a normal sensitivity in the cylinder-plate test to helvolic acid (Figs. 2 and 3). By seeding a plate with *Staphylococci* trained to grow in the presence of helvolic acid (1 in 20,000) in liquid medium, and then picking off resistant colonies formed inside the inhibition zones produced by *P* and *S*, a culture was obtained which showed resistance, when used in the cylinder-plate test, to all three substances, though its resistance to helvolic acid was reduced during the procedure.

In the case of *S* and helvolic acid it was shown by measurements of the activity of these substances before and after cultures had grown in their presence that the resistant strains of *Staphylococci* did not inactivate the antibiotics in the medium.

The difference in the nature of the inhibition zones produced by *P* or *S* from that produced by helvolic acid was reflected in the different types of growth curves shown by the *Staphylococcus* in the presence of these substances in liquid media. Fig. 4 shows growth in normal heart broth (*p*H 7·3) and in heart broth containing *S* (1 in 15,000), from an inoculum of 50×10^6 *Staphylococci* per ml. In the presence of the antibiotic the cells were at first killed rapidly and approximately logarithmically (mean survival time about 30 minutes). After 4 hours, when the number of viable cells per ml. had fallen to $0{\cdot}70 \times 10^6$, the survivors began to multiply at a rate which soon reached that of a normal culture in the logarithmic phase, having a mean generation time (m.g.t.) of 28 minutes. These changes were accompanied by an initial decrease and subsequent increase in the total number of organisms, but lysis only reached its maximum after more than 6 hours and was clearly a secondary process superimposed on that causing the death of the cells. The final 'stationary population' attained in the presence of *S* was much smaller, however, than that reached by the control culture. It appeared from this curve (Fig. 4) that when *S* was tested by the cylinder-plate method most of the organisms within the inhibition zone were killed, but a small proportion survived and grew rapidly in the presence of the antibiotic, leading to the appearance of isolated resistant colonies

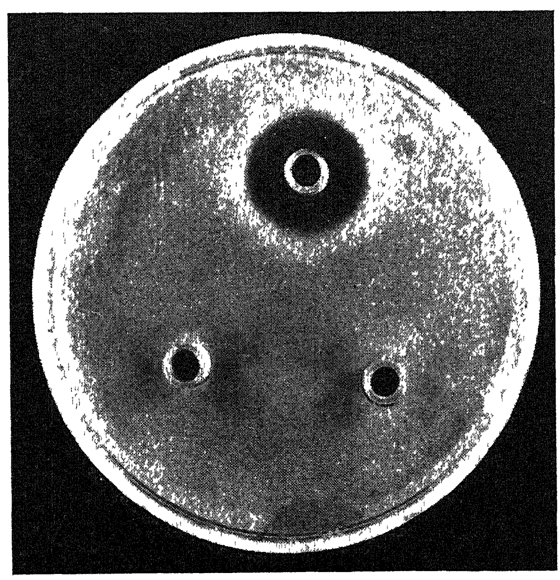

Fig. 3. SEEDED WITH *Staphylococcus* DERIVED FROM COLONY RESISTANT TO *S* ON PLATE 2

Top. Helvolic acid (1 in 5,000). Bottom left: *S* (1 in 2,000). Bottom right: *P* (1 in 200)

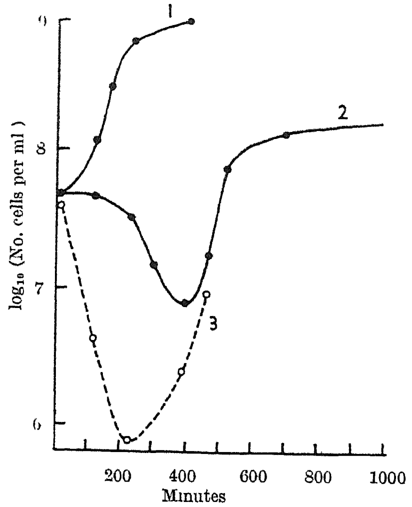

Fig. 4. GROWTH OF *Staphylococcus aureus* IN THE PRESENCE OF S (1 in 15,000). (1) CONTROL CULTURE; (2) TOTAL CELLS IN THE PRESENCE OF S; (3) VIABLE CELLS IN THE PRESENCE OF S

Fig. 5 illustrates the remarkable facility with which the *Staphylococcus* became resistant to helvolic acid (1 in 200,000) in heart broth (pH 7·3). The inoculum was 6×10^6 cells per ml. For nearly twelve hours growth was very slow, the m.g.t. being 260 minutes. A transition then occurred to a much faster rate of growth in which the m.g.t. fell to 57 minutes before the stationary population was approached. When cells from this culture were used to inoculate fresh medium containing the same concentration of helvolic acid there was rapid growth (m.g.t. 30 minutes) after a short lag period of 70 minutes. Thus after less than seven divisions the *Staphylococci* were able to grow almost as well in the presence of this concentration of helvolic acid as in normal medium. Their capacity to do this was not lowered significantly by three subcultures in normal medium. Cells which had grown in the presence of 1 in 200,000 helvolic acid were then able to grow readily in 1 in 20,000 helvolic acid (lag 70 minutes, m.g.t. 53 minutes). Curves qualitatively similar to those given by helvolic acid have been obtained by growing bacteria in the presence of other antibacterial substances[6,7].

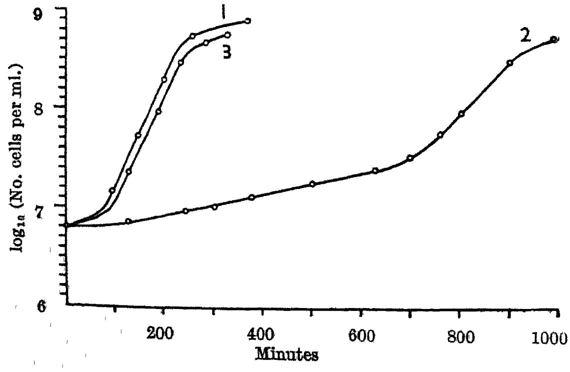

Fig. 5. ADAPTATION OF *Staphylococcus aureus* TO GROWTH IN THE PRESENCE OF HELVOLIC ACID (1 IN 200,000). (1) CONTROL CULTURE; (2) PRIMARY CULTURE IN HELVOLIC ACID; (3) SUB-CULTURE FROM (2) IN HELVOLIC ACID

Even at a concentration of 1 in 10,000, helvolic acid had no bactericidal effect, at least for several hours, on the *Staphylococcus*[8] (H strain). Its predominantly bacteriostatic action was in harmony with the fact that it produced clear inhibition zones in the cylinder-plate test.

It may be remarked that in the presence of certain concentrations of penicillin the growth-curve of the *Staphylococcus* in liquid medium[9] is similar to the curve obtained in the presence of S (Fig. 4). Nevertheless, penicillin gives clear inhibition zones on plates. The proportion of organisms which survive and multiply when *Staphylococci* are first brought into contact with suboptimal amounts of penicillin, however, varies very rapidly with changes in the concentration of the drug[10]: the part of the inhibition zone in which isolated colonies could develop might thus, in this case, be too small for the phenomenon to be apparent. Eriksen[11] found that when plates were seeded with *Staphylococci* which had been previously subcultured in the presence of penicillin in liquid medium many resistant colonies developed inside the zones of inhibition.

The question arises whether the strains of *Staphylococci* resistant to P, S or helvolic acid were derived merely by a process of natural selection from a bacterial population which was initially heterogeneous, or whether they were produced because staphylococcal cells could adapt themselves very rapidly to grow in the presence of concentrations of these antibiotics to which they were normally sensitive.

The simplest hypothesis which might have been put forward to account for the development of resistant strains in terms of natural selection was that the original H strain contained small amounts of a number of substrains, each of which was stable and was resistant to a given antibiotic. This hypothesis had two consequences, however, which made it untenable. First, it required that the emergence by natural selection of a substrain resistant to one of the antibiotics should have been accompanied by the recession and eventual elimination of other resistant substrains. In fact, a strain of *Staphylococci* resistant to P produced cells resistant to S as readily as did the original H strain. Secondly, it required a culture derived from a single cell of the H strain to have comprised cells which were all sensitive, or all resistant, to a given antibiotic. Experiment showed that the inhibition zones produced by P or S on twelve plates seeded with cultures derived from different single colonies of *Staphylococci* (obtained by plating out a culture of the H strain which contained, for the most part, discrete cells) were all very similar, each having about the same diameter and containing approximately the same number of resistant colonies. Even if all the single colonies had not been derived from single cells the probability that some of them would have contained only 'sensitive' cells, had these been present in the original culture, is very large. Similarly, the sensitivity of the *Staphylococcus* to helvolic acid in liquid medium was not changed by using cultures derived from single colonies. These difficulties could have been partly circumvented by supposing that the H strain, even when grown in normal medium, was continually producing 'variants' which were resistant to one or other of the antibiotics, so that a single cell gave rise to a heterogeneous population. Lewis[12] considered that this was the manner in which *Bact. coli mutabile* acquired the capacity to ferment lactose, and Demerec[10] thought it was the way in which the *Staphylococcus* became resistant to penicillin. In the present case, however, such an explanation was not readily acceptable. Unless the variants were unstable, or divided more slowly than the normal cells, their proportion would continuously increase during the growth of normal cultures, since new variants would be formed both from normal cells and by division of the variants themselves. In fact, the strains of *Staphylococci* resistant to *P*, *S* or helvolic acid showed no tendency, at least in pure culture, to undergo a rapid reversion, nor did their growth-rates appear to differ significantly from that of the original *H* strain; but nevertheless they were obtained just as readily from samples of the *H* strain which were derived by one subculture from a single colony as from a sample which had passed through a number of subcultures.

These considerations indicate that the development of resistance by the *H Staphylococcus* to *P*, *S*, or helvolic acid is not easily explained by a theory based exclusively on natural selection. On the evidence available a more satisfying hypothesis is that the process is caused initially by a specific modification of staphylococcal cells which is induced by the antibiotic concerned; although, once any such modified cells have been formed, natural selection may obviously accelerate the emergence of a resistant strain.

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EDUCATION IN THE BRITISH ARMY*

By Major-General CYRIL LLOYD, C.B.E., T.D.

Director of Army Education

III: Education in the Post-War Army

THE years between the two World Wars were notable for two distinct phases which are important to remember. First there was the apathy in low places and the frequent opposition in high ones which met the newly formed Army Educational Corps as it faced its new task. Second was the change of attitude on the part of officers and men as the grinding, hard and courageous work of those early years began to show its effect. The earlier trickle of men coming forward for higher education in their leisure time became a steady stream in the late 'twenties, and by the time war broke out it was in some places becoming a flood which could be contained only with difficulty. No less important was the change in the attitude of senior officers; opposition changed into co-operation, interest and, in some cases, real enthusiasm. As horse and foot were replaced by the machine, the traditional conception of the still-tongued, non-thinking but superbly disciplined soldier gave place to a new ideal: the man who would think, not at the rate of the moving horse, but at the speed of the motor-vehicle which was rapidly superseding it; a man who would observe discipline not from fear of punishment, but because of a real understanding of its efficacy. This was real progress; but it was still hampered by the shackles of an elaborate and extensive examination system which limited the horizon and absorbed, in great quantities, time and energy which could have been far more profitably employed.

With the outbreak of war in 1939 all official educational work ceased for a time, but it soon came to be realized that, in total war, care of the soldier's mind is no less important than care of his body and soul: morale must be built up, war-weariness and boredom must be eliminated, mental stagnation must be replaced by mental alertness; knowledge must make the soldier the full man. The scheme which sought to achieve all these ends brought to army education the rich experience of free adventure in an unlimited field. Instead of trying to entice the soldier into his academic parlour, the teacher was forced to go forth and mould his knowledge and culture to the lives of men who in peace-time make machines, build houses, drive trains and dig coal, and in so doing his gains have been great.

Not the least of the advantages which accrued was the bridging of the gulf which had too long separated military from civilian educational administrators, and the release period scheme has provided opportunities for an extension of this advantage: the close contact and collaboration between the War Office and the Ministry of Education is being repeated at lower levels by liaison between His Majesty's inspectors and command and district education officers in the field both at home and overseas.

The continuation of compulsory service is important, because it introduces considerations which would not exist were we concerned only with the long-service professional soldier. It will, for example, be important to make the militia-man understand why he is compelled to become a soldier: it will be equally important to prepare him for those civic responsibilities to which he will return at the end of his militia service.

At a time when, under the Education Act of 1944, educational opportunities in the civil field will be progressively expanding, the soldier, be he professional or militia-man, will have the right to demand similar opportunities within the Service. Education is a national and not a sectional privilege, and it should be a continuous process unbroken by the accident of compulsory or even of voluntary service. If this be accepted, we must accept also the need for a continuing close liaison between the War Office and the Ministry of Education, for how else can continuity of purpose be achieved? Moreover, the circumstances of Service life make the Army an admirable ground for controlled experiments which might be less easy to conduct in the freer field of civilian adult education.

It will be important to make the militia-man realize that he is an essential part of the Army: this means that there must be no discrimination in units where militia-men and professionals serve side by side, for there is only one British Army and all who share its service share its honour. All

* Continued from page 780.

the same, it provides an obvious problem for those who plan the details of organisation and syllabus.

Perhaps the greatest advance made in army education during the war years has been the recognition of the soldier's right and need to develop the personal side of his life. Sir Ronald Adam will be long remembered for his successful efforts to provide for the soldier wide opportunities to develop cultural interests, hobbies and non-vocational craftsmanship. It is idle to suppose that the Army will readily relinquish what it has learnt to appreciate. Moreover, it must be remembered that the bulk of the Army will be, not at home, but abroad where amenities are fewer, where boredom is the bitter enemy of morale and where the homeliness of contact with the civil population is a blessing rarely enjoyed.

We can therefore now proceed to a broad classification of the needs of the post-war British soldier. First there is the continuation of general education, which must include current affairs and citizenship, and, for those who need it, basic education of the most elementary type. Second comes professional education, the importance of which lies in its potential influence on our national efficiency and prosperity, and herein there must this time be no overlooking the claims of the long-service soldier. Finally there is education for a richer life through appreciation of the arts, skill at handicrafts and an ability to derive pleasure in the wide fields of scholarship and culture.

An examination of the factors of the problem would be incomplete without consideration of the problems of staff requirements, which will be inescapably large because of the variety of the provision required for numbers which for many years to come will be very great. Certainly a larger Army Educational Corps than before the War will be required, and this means improvement in prospects of pay and promotion sufficient to attract the right type of man in adequate numbers. It would, however, be idle to hope to get through the financial and man-power limitations any plan for staffing the entire plan with fully qualified, and therefore expensive, teachers. There should, however, be no dearth of potential talent in the ranks of the Army. Recent improvements in pay will, it is hoped, attract into the Army men of higher educational attainment, and, compulsory service having been approved, the militia should provide a good leavening of prospective teachers and others suitable for educational work of all kinds.

It is obvious that a full picture cannot be painted while so many essential military details have yet to be decided; but it is possible to begin to develop the broad outlines to which form and colour will be added in due course.

In order that the close association with civil adult education in war-time may be continued and strengthened in peace-time, the Secretary of State for War has set up an Army Education Advisory Board. This Board is composed of persons in civil life with educational qualifications and experience, and of representatives of the Ministries of Education and of Labour and National Service and of the Scottish Education Department. It is the responsibility of the Board to keep under review the educational policy of the Army and to advise the Secretary of State on such matters connected with Army education as it thinks fit and upon any questions referred to it by him. The chairman of the Board is Sir Philip Morris, vice-chancellor of the University of Bristol, who brings to the Board not only his wide knowledge of civil education but also the valuable experience of the problems of army educational administration which he gained as Director-General of Army Education. The Army will therefore start its new scheme assured of its civilian contacts, and this should go far to ensure that education in the Army is an integral part of the national plan.

It is essential that education in the Army should be a normal part of military life designed to fit into its place in daily routine. This being so, the military 'unit' must be the basis of educational organisation, and the commanding officer must be charged with the responsibility for his unit's educational efficiency in the same way and to the same extent as he is responsible for all other aspects of his unit's efficiency and welfare. In the main he will be responsible for a general scheme of community education which will be a compulsory part of the day's work. Community education has here a wider connotation than its present one in the release scheme, where it covers only current affairs and citizenship. In the future plan it covers not only current affairs and citizenship but also all those basic subjects which are the necessary equipment of the good citizen; for example, English, calculation, geography and history. Side by side with this compulsory work, the unit will be required to provide individual education on a voluntary basis in the men's own time. Here the man could continue studies he may have started before joining the Army, or he could acquire new interests in art or music, in literature or handicrafts, according to his tastes and the resources locally available. It seems likely that instructors for this unit work will be provided from unit resources as was done both before and during the War with considerable success. Suitable non-commissioned officers would be given a course of, say, three months at the army school of education, where they would receive training in teaching method and more advanced instruction in selected subjects.

It would be unfair to expect the unit with its limited teaching resources and its heavy training commitments to undertake the more difficult types of teaching: these would be provided or organised at garrison-level, where better qualified instructors could be pooled and, possibly, supplemented from external sources. At one end of the scale in this group would be the illiterates and near-illiterates receiving compulsory basic education to fit them to take their places in the community life and community education of their units. At the other end of the scale would be higher education on a voluntary basis, and here it is probable that liaison with local education authorities would, at home at least, enable troops to take advantage of classes in the technical schools, evening institutes and art schools. It is hoped that garrison classes in this group may be able to develop on the lines of the study centres which have grown up everywhere during the War as a result of individual initiative and which have given education a habitation and a home.

A third type of provision which finds a place in preliminary plans is re-settlement education (as opposed to re-settlement training) for regular soldiers. Here it is possible that the correspondence course, the local technical school and garrison classes might all contribute to the preparation of the long-service man for his return to civil life. The Secretary of State for War went even further than this when in opening one of the Army's formation colleges, he expressed a hope that it would be possible in the post-war period to retain at least one such institution for the benefit of the long-service soldier.

Examinations, much as we dislike them, serve two important purposes. First they are required as a part of the process of assessing the man's all-round ability for purposes of proficiency pay. If, as seems probable, a test of this sort cannot be escaped, it will be devised to do its work in a manner which will at once avoid heavy waste of time and effort and elude the constricting danger of a fixed and immutable syllabus. The second purpose served by the examination is the provision of the 'scrap of paper' which experience proves is highly valued by soldiers at all levels as a passport to well-paid employment when they leave the Army. To satisfy his needs in this respect it is felt that the soldier should be encouraged to take the examinations open to his civilian brothers, for these are more acceptable to civilian employers, who in the past have shown diffidence in accepting the less familiar Army certificates of education.

In addition to the types of possible provision described, there are the institutions which train boys as apprentice tradesmen: these will probably continue along much the same lines as hitherto, though, of course, general education will have to be brought into line with that in units. Band-boys are, and always have been, a special problem, for the numbers of them in units are usually too small for satisfactory arrangements to be made to meet their educational needs. Proposals are, however, being examined with the view of eradicating the weaknesses of the pre-war system so that band-boys may be assured of an educational opportunity worthy of the future that lies before them.

At the end of a period of war few will need convincing that however gallant and efficient the rank and file may be, their efforts will be nullified if they are not backed by an efficient staff corps. Army education as an extensive operation on a global scale will no less need a highly trained and efficient staff corps to plan, stimulate, administer and provide. Between the Wars the Army Educational Corps suffered continuously from a sense of frustration: promotion, slow at all levels, was almost non-existent in the intermediate commissioned ranks; numbers were inadequate to develop the opportunities which all keen men could see; the burden of an examination system kept educational staffs enslaved to the chores of education when they should have been leading the way to its shining corridors. As a result, few were attracted to its service from outside the Army.

Proposals have now been accepted which will ensure a constant flow of new blood from the civilian system and, for those who wish to make a career in Army education, prospects of pay and promotion equivalent to those in other corps and in the education profession generally.

Much praise has been given to the Army for its great educational efforts during and since the War; but if these efforts are to survive and flower in the years of peace, more will be required than mere lip service. If Army education is worth while in war, it is doubly worth while in peace, and if it is worth while it must be staffed and equipped in a manner worthy of its great task. This is not a matter of mere domestic politics for the Army; it is a matter of vital concern for the nation, of which the Army is a living, though in peace often a forgotten and neglected, part.

OBITUARY

Sir Frank Heath, G.B.E., K.C.B.

Henry Frank Heath was born on December 11, 1863. He was the eldest son of Henry Charles Heath, miniature painter to Queen Victoria. He was educated at Westminster School and University College, London, after which he spent a year at the University of Strassburg. When he came back to England he was appointed professor of English at Bedford College, London, and lecturer in English language and literature at King's College, London. He held these posts until 1895, when he became assistant registrar and librarian of the University of London. He was appointed academic registrar in 1901, holding the post only for two years, when he joined the Government service as Director of Special Enquiries and Reports under the Board of Education (1903–16). He became principal assistant secretary of the Universities Branch of the Board from 1910 until he was appointed secretary to the Department of Scientific and Industrial Research in 1916. He retired from the Department in 1927, and from then until the end of his life gave voluntary service to a number of important institutions. He died on October 5.

These are the bare facts of Heath's long life and of his great services to the State, to science, and to education. Few men, except those who knew him well and worked in intimate co-operation with him, know how great these services were.

Heath first became interested in scientific education and research when he became head of the Universities Branch of the Board of Education, which was formed in 1910. There existed at that time a Treasury Advisory Committee on Universities, of which Heath was a member. This Committee advised on Treasury grants to certain university faculties but not to the universities of Great Britain as a whole. It was converted in 1910 into a general advisory committee on universities, and attached to the Board of Education. Sir William McCormick was appointed chairman, and Heath ceased to be a member, as the recommendations of the Committee came to him to administer. It was then that he formed that close friendship, and began the long association, with McCormick that was to prove so fruitful.

In the course of his work at the Board of Education, Heath devised simple and effective provisions for giving grants to universities in respect of engineering and medicine. Previously such grants had only been given under the attendance regulations for technical schools. Before long these grants were absorbed in block grants to the universities; and the medical schools, in London and in the provinces, came to be State-aided under the new system. All this work of Heath's, in which he showed the vision and the administrative ability which were so characteristic of him, and which are seldom combined in one man to such a degree, led finally to the evolution of the University Grants Committee, and to the great spread of State aid to the universities of Great Britain without affecting their autonomy.

When the War broke out in 1914, it soon became painfully clear how dependent Britain was for vital war material on German industries, and how far we had failed to keep pace with Germany in the application of science to industry. Heath acted with characteristic vigour. By Christmas 1914 he had submitted a memorandum to the president of the

Board of Education, pointing out how the failure of industry to enlist the services of science had caused a great shortage of men trained in scientific research at the universities. This highly important memorandum was referred to a small secret committee under Sir William McCormick. By May 1915 the Government, on the advice of this committee, had decided to establish a permanent organisation for the development of scientific and industrial research, and when the Royal and Chemical Societies approached the Government to ask for the establishment of a National Chemical Advisory Committee, they received the reply that a much wider attack on the whole problem was in its initial stages.

The Department of Scientific and Industrial Research was formed in 1916 on Heath's plan. There can be little doubt that many of his ideas were improved in detail by McCormick's committee; but the whole scheme was primarily due to his imagination and foresight. It was he in particular who foresaw the advantages of placing the new Department, which was destined to have such close relations with other departments of State as well as with the universities and industry, under the Lord President of the Council, who had then no departmental duties. This decision has had the consequence that the Lord President of the Council has become the chief Minister of the Crown responsible to Parliament for advice on the general scientific development of the country. The Medical Research Council, which was the successor of the Medical Research Committee of the National Health Insurance Joint Commission, the appointment of which pre-dated the Department of Scientific and Industrial Research, was placed under the Lord President in 1920. The Agricultural Research Council became responsible to him in 1931.

McCormick was appointed chairman of the Advisory Council of the Department, and Heath was made its permanent secretary. So it came about that the first great venture of the State, in this or in any other country, to exercise a comprehensive influence over the development of research to meet national needs was guided by two professors of English. Needless to say, there was much criticism at the time in the scientific world, criticism that was wholly falsified by events. Speaking as his successor, I record emphatically that I can think of no scientific man at the time who could have done what Heath did in the nursing of this new venture through a most difficult period, and in its final establishment in a secure position. Nor should McCormick's services in this respect ever be forgotten. He supplied qualities that Heath lacked. Heath was apt to be too interested in, and too worried about, details. A talk with McCormick, who cared nothing for details, often resolved Heath's difficulties and refreshed his mind. McCormick's natural geniality, too, and interest in human beings, made much easier the relations between Heath and the great men of science who served on the first Council of the Department. Heath was indeed the driving power, and McCormick was the lubricant.

During the next few years the main structure of the Department was erected. The scheme for the establishment of research associations, which was due to Heath, started in 1917. The Fuel Research Board was established in 1917, the Food Investigation Board in 1918, and the Building Research Board in 1920. Sir George Beilby was the first director of research and chairman of the Fuel Research Board. He was succeeded later on as chairman by Sir Richard Threlfall. Sir William Hardy was the first director of food investigation. Beilby, Threlfall and Hardy were the three members of the Advisory Council who had most executive responsibility for the research of the Department. Beilby and Threlfall were great industrialists who had also done work of high scientific importance. Hardy, the best scientific worker of the three, had no experience of applied research until he joined the Department. All three had vigorous personalities, strong individualities, and did not suffer fools gladly. But all three got on very happily indeed with Heath, formed close friendships with him, and were always prepared to be guided and influenced by him. It is difficult to think of a better tribute to Heath's own personality and work than this statement.

The general structure of the Department has not changed since those early days. New research boards and stations have been added, but they have been formed on Heath's original plans, which have stood the test of time. Research associations have had a chequered career, and are being exposed at the moment of writing to some severe criticism. Their establishment was a bold experiment, fully justified, and their present value is far greater than some of the critics conceive. Whatever improvements are necessary and desirable in detail, no one would wish to abandon the general scheme. What is more, the basic idea of forming associations to meet the needs of the older and scattered industries is being copied in other countries.

In 1925 Heath was invited by the Government of Australia to advise on the development of scientific and industrial research. After a comprehensive survey he recommended that the existing Commonwealth Institute of Science and Industry should be developed to a Council of Scientific and Industrial Research to serve all Australian national needs in science, industry and agriculture. His recommendations were adopted by the Government and passed into law in June 1926. He then went on a similar mission to New Zealand, where the Government accepted his recommendation to establish a Department of Scientific and Industrial Research. The National Research Council of Canada, which replaced the Honorary Advisory Council for Scientific and Industrial Research, had been established in 1924. In South Africa developments have been slower, and it is only recently that a similar council has replaced the organisation for the encouragement of research that was the responsibility of the Minister of Mines and Industries. All these developments have resulted from Heath's original report to the Government of the United Kingdom in 1915.

Soon after Heath returned from these visits he resigned his secretaryship of the Department. It was not necessary for him to do so; but he felt that his main work had been done, and that the time had come to hand over the chief executive responsibility to a scientific man. All three of Heath's successors have been men of science, and it is highly probable that all future successors will be; but Heath will always have a special place of honour in the history of the Department.

After his retirement in 1927, Heath became for a short time the secretary, and afterwards the honorary director of the Universities Bureau of the British Empire, and threw himself with the same passionate eagerness into its affairs as he had into the larger affairs of State. He was an active governor, from 1931 until his death, of the Imperial College, where his wide knowledge and experience of education and research, and his constructive criticism, were of inestimable value. His many other activities included the chairmanship (1935–39) and the vice-chairmanship since 1939 of the British Standards Institution, and membership of the Royal Commission for the 1851 Exhibition since 1924. Whatever he did was done thoroughly and well; no one ever turned to him in vain for help.

Heath's publications include chapters on English language and literature to the time of Elizabeth in "Social England". He was co-editor with A. W. Pollard and others of the Globe Chaucer, and editor of the *Modern Language Quarterly* from 1897 until 1903. Many of his best writings were published anonymously in official documents, such as the annual reports of the Department of Scientific and Industrial Research; but fortunately he found time, before his death, to complete a book on "Industrial Research and Development" in collaboration with A. L. Hetherington, a close friend and colleague for many years.

Sir Frank married twice. His first wife, Antonia Johanna Eckenstein, died in 1893, only a year after their marriage. In 1898 he married Frances Elaine Sayer, who died in 1939. Two sons of the second marriage survive him. H. TIZARD

NEWS and VIEWS

Royal Society

Annual Meeting

THE anniversary meeting of the Royal Society was held, as customary, on November 30, and the president, Sir Robert Robinson, delivered his presidential address, a main part of which is printed on p. 815 of this issue, and also presented the medals for 1946 (see p. 841). In addition, he made some brief comments on the relationship of scientific men to world affairs. He welcomed Sir Henry Dale's plea last year for the general release of scientific knowledge. Speaking of the danger to scientific ideals and integrity in the conception of 'total war', he pointed out that men of science are faced with a dilemma—a conflict between their ideals of service to humanity and their duty as citizens of a democratic community—which can only be resolved by the establishment of real friendship and concord among the nations of the world. Speaking for himself, he said that all men of science should strive for the promotion of international peace and the outlawry of all methods of warfare which by their nature involve 'total war'. The existence of the universal brotherhood of scientific workers shows that this hope is not impractical idealism. Nevertheless, in this connexion there can be no clear-cut distinction between peace and war, and a nation's defences must be prepared at all times against attack. Sir Robert continued, "it is inconsistent to praise our scientists for their outstanding contributions to the war effort and at the same time to suggest that they offend against our ethical code if they serve the country in a similar fashion during an uneasy peace. It is useless to attempt to disguise the fact that such service implies some sacrifice of freedom. During the War the scientific effort was nation-wide and control extended to many university departments. Nevertheless, the universities have preserved intact their precious liberty of action, and I see no signs of any attempt to curtail it. Surely this suggests a feasible line of demarcation in that extra-mural contracts, placed by Service departments with the universities, need not, and should not, contain any clauses restricting free publication of the results. Although it has sometimes been irksome, the refusal of many universities to accept theses that cannot be published is a step in the right direction."

Officers and Council

THE following is a list of those elected as officers and Council of the Royal Society at the anniversary meeting. *President*, Sir Robert Robinson; *Treasurer*, Sir Thomas Merton; *Secretaries*, Sir Alfred Egerton and Sir Edward Salisbury; *Foreign Secretary*, Prof. E. D. Adrian; *Other Members of Council*, Dr. C. H. Andrewes, Prof. W. T. Astbury, Prof. W. Brown, Dr. E. C. Bullard, Prof. A. C. Chibnall, Prof. C. A. Lovatt Evans, Dr. N. H. Fairley, Prof. R. A. Fisher, Prof. S. Goldstein, Prof. E. L. Hirst, Prof. H. W. Melville, Prof. M. H. A. Newman, Prof. M. L. E. Oliphant, Dr. C. F. A. Pantin, Prof. H. H. Read, Sir Reginald Stradling. In his anniversary address, Sir Robert Robinson announced the resignation of Mr. John D. Griffith Davies, assistant secretary of the Society; Mr. Griffith Davies has been appointed a member of the Library Committee and will be chairman of a sub-committee preparing for the celebration of the tercentenary of the Society.

Nobel Prize for Physics:

Prof. P. W. Bridgman

PROF. P. W BRIDGMAN, to whom the Nobel Prize for Physics for 1946 has been awarded, is celebrated for his comprehensive researches into the properties of matter at very high pressures, which began in 1906 and have continued with unabated vigour to the present day. By the ingenious applications of principles in themselves simple and by the informed utilization of new steels, he extended the range of pressures at which systematic measurements could be made from 3,000 atmospheres, the limit reached by Amagat, to 12,000 atmospheres. Up to this pressure he measured, for example, compressibilities, viscosities, electrical conductivities, thermal E.M.F.'s and transition points of a large number of elements and compounds, with results of the highest interest. This work, which necessarily involved the working out of new methods of measuring pressure, is described in his book "The Physics of High Pressure", which appeared in 1931 and has become the classic of the subject.

Since then, Bridgman has again extended the range of pressures. By constructing the vessels of the steel known as 'carboloy' and by special methods of construction, including, for the highest pressures, the immersion of the pressure vessel in a fluid which is itself maintained at 30,000 atmospheres, he has pushed the limit up to 100,000 atmospheres. A number of systematic measurements of polymorphic transitions and of compressibilities have been made up to 50,000 atmospheres. It is an extraordinary feat to have increased thirtyfold the range of pressures which was practicable when he first took up the subject. Clearly, the pressures now reached are of the greatest importance not only to physicists, chemists and engineers, but also to geologists. Bridgman's work has been a source of strength to the various schools of high-pressure work which have been set up of recent years. A valuable review of work in the field of high pressure since 1930 was published at the beginning of the present year by Bridgman in the *Reviews of Modern Physics* (vol. 18, pp. 1–93). Bridgman has written several outstanding books, besides his standard treatise on high pressure, dealing not only with the thermodynamics of the processes in which he is interested, but also with such subjects as dimensional analysis and the general philosophical aspect of modern physics.

Nobel Prize for Chemistry:

Prof. J. B. Sumner

BIOCHEMISTS will learn with pleasure that Prof. J B. Sumner's name is included among those who share, this year, the Nobel prize for chemistry. Prof. Sumner, professor of biochemistry in Cornell University, will always be remembered as the first person to succeed in crystallizing an enzyme—urease. This he accomplished in May 1926, and in doing so he helped greatly to dissipate the fog of obscurity which had surrounded the subject of enzyme chemistry. The isolation of the crystalline enzyme suceeded only after many years of preliminary work, during which period every conceivable method of purification was tried. Eventually, after studying the constituents of the jack bean and paying special attention to the properties of its proteins, an extremely simple procedure for the isolation of urease was adopted. It consisted of stirring 100 gm. jack bean meal with 500 ml. of 32 per cent acetone and allowing the mixture to filter in an ice chest. After standing overnight, the filtrate was seen to contain colourless octahedral crystals, which were found to be crystals of urease. Sumner's claim to have isolated the first enzyme in crystalline form was strongly contested, especially by members of the Willstätter school, and biochemists will recall the general scepticism with which the claim was at first received. Sumner's finding was, however, quickly confirmed, and it was followed during 1930, 1931 and 1933 by the crystallization of the proteolytic enzymes pepsin, trypsin and chymotrypsin by Northrop, and by Northrop and Kunitz. More than twenty enzymes have now been obtained pure, among these the well-known enzyme catalase crystallized by Sumner and Dounce in 1937. The use of crystalline enzymes has led to a major advance in our knowledge of the chemistry of enzymes, and they are now familiar objects of study in the hands of biochemists and physical chemists. Sumner's name is also associated with much interesting work on enzyme kinetics and on the production of anti-enzymes by immunological methods.

Dr. W. M. Stanley

HALF of the Nobel Prize for Chemistry for 1946 has been awarded to Dr. W. M. Stanley and Dr. J. H. Northrop of the Rockefeller Institute for Medical Research, Princeton, New Jersey, and it is appropriate enough that these two workers should be honoured together since an important part of Stanley's work was carried out by means of Northrop's technique. It was in 1935 that Stanley announced (*Science*, **81**, 644) the isolation of the virus of tobacco mosaic in crystalline form, and thereby opened the way to the intensive studies of plant viruses which in the last decade have revolutionized the whole subject Although Stanley was not the first to conceive of a virus as a chemical substance rather than an organism —Vinson and Petre may be mentioned as pioneers in this direction—he was the first to isolate a crystalline or paracrystalline virus protein, and thus enabled workers to visualize a virus as a tangible entity rather than a mysterious agent the existence of which could only be deduced from its effects on its host. This discovery was soon confirmed by workers in Britain and elsewhere. There was at first a good deal of scepticism as to whether the protein really was the virus itself. The biologist was loth to exchange his conception of a very small organism for that of a crystalline protein with the power to multiply, and the chemist was equally unwilling to contemplate the possibility of a mutating molecule. Stanley, however, showed that the virus protein could be obtained from plants botanically unrelated such as the tobacco and the phlox, but only if these plants were infected with tobacco mosaic virus. He also showed that a closely related strain of the tobacco mosaic virus could be isolated, and that it was similar to the first but yet possessed properties which were distinctive and characteristic. Nowadays, no plant virus worker doubts that the virus and crystalline protein are one and the same; several more viruses have been isolated in crystalline form, four of them as three-dimensional crystals, and all have been shown to be nucleoproteins.

Dr. John H. Northrop

THE nature of the enzymes was a matter for considerable speculation so recently as twenty years ago, and the isolation of the gastric proteolytic enzyme pepsin by Dr. John H. Northrop in 1930 as beautiful hexagonal crystals having the composition of a protein did much to confirm their protein nature. Various tests applied to the pure preparations showed beyond reasonable doubt that the enzymatic activity was intimately related to the protein, and subsequent work by Northrop and other workers has amply confirmed the protein nature of the soluble enzymes. In 1932, in collaboration with Dr. M. Kunitz, also of the Rockefeller Institute, he was responsible for the isolation and crystallization of trypsin, and afterwards of several other proteolytic enzymes from pancreas. In the course of these studies, several inactive precursors of these enzymes were also isolated in a pure form, and it was found that trypsin and pepsin are capable of synthesizing themselves from their precursors. This autocatalytic synthesis has been compared with the multiplication of the viruses, but it has not the same specificity, as, for example, chicken pepsin is formed from chicken pepsinogen whether the reaction is catalysed by swine pepsin or chicken pepsin. It is interesting, however, that a possible inactive precursor of the tobacco mosaic virus has been reported recently. Besides his work on the isolation of the proteolytic enzymes and their precursors, Dr. Northrop has been responsible for studies on enzyme kinetics, on the estimation and purification of bacteriophage and on a large number of physico-chemical studies of which probably the best known are on the diffusion of solutes through porous membranes, on microcataphoresis and on the application of Gibbs's phase rule to the solubility of protein solutions as a test of their homogeneity.

Prof. W. T. Astbury, F.R.S.

At the recent celebrations of the liberation of the city of Strasbourg in 1918 and 1944, the solemn 're-entry' of the University was marked, on November 22, by its first honorary degree ceremony since the end of the War. Among other recipients, the degree of *Docteur honoris causa* was conferred on Prof. W. T. Astbury, of the Department of Biomolecular Structure and Textile Physics Laboratory of the University of Leeds. Prof. Astbury was also recently elected a member of the Royal Society of Sciences of Uppsala.

L.M.S. Railway: Scientific Research

Mr. F. C. Johansen has been appointed deputy scientific research manager of the L.M S. Railway. Mr. Johansen graduated with first-class honours from King's College, University of London, gaining the degree of B Sc.(Eng.), and afterwards obtaining his M.Sc. On leaving the university, he took up an appointment with the Yorkshire Electric Power Co.; later he joined the National Physical Laboratory, where he did research into certain aspects of fluid motion, and carried out a comprehensive investigation into air resistance of trains. In 1932 he joined the Scientific Research Department of the L.M.S Railway as engineering research officer.

University of Glasgow

Dr. Eric Clar has arrived from Czechoslovakia to work in the Chemistry Department as an I.C.I. Fellow. After graduating at Dresden and working for a time at Cambridge, Dr. Clar became head of the Chemistry Department of the Istituto Ronzoni at Milan in 1930. Since 1933 he has been working mainly in his own laboratory at Herrnskretschen, but has also been part-time lecturer in the University of Prague and has had connexions with Rutgers A.G. at Niederau. For many years he has been especially interested in polycyclic hydrocarbons and their derivatives, and he is author of the monograph, "Aromatische Kohlenwasserstoffe" (1941).

Mr. Cyril A. Halstead has been appointed assistant in geography. The following resignations have been accepted: Dr. G. F. Asprey (botany) to become lecturer in plant physiology in the University of Aberdeen; Mr. E. Duffy (bacteriology) to become assistant pathologist to the Royal Cancer Hospital, Glasgow; Dr. Janet S. F. Niven (pathology) to join the staff of the National Institute of Medical Research, London.

The North Ferriby Boats

Little is known about the efforts of primitive man in northern Europe to overcome the inherent defects of the dugout boat and to develop a seaworthy planked vessel. The Scandinavian tradition was to use the clinker build; but apart from the Hjortspring canoe, really early examples of this kind are so incomplete that it is impossible to gather any clear idea of their shape or size. In all of them, however, the planks are secured by stitching. The remains of two large boats as primitive as any planked vessel from Northern Europe and, in one case, sufficiently complete to allow reconstruction of the original form to be made with fair certainty, have been found by Mr. E. V. Wright and his brother, the first in 1937, the second in 1941. They were between high and low water, buried in the old river clays on the north bank of the River Humber at North Ferriby in east Yorkshire. Much of the first boat was lost during the War by erosion; but records survive of what has disappeared. The end of the War made it possible to recover what was left. The enthusiastic support was secured of the late Sir Geoffrey Callender and the National Maritime Museum, who organised the salvage of the boats with the help of the Admiralty. Although the first boat was not extracted in one piece, as was hoped, no information or timber was lost, and a successful restoration is certain.

The boats were highly developed examples of a technique of sewing planks together to form a 'fabricated dugout'. They had a flat bottom made up of three composite planks, the centre one being turned up like the end of a punt at the end that was preserved complete, and probably at the other also. The centre plank was twice as thick as the others but was made of two lengths joined with an absurdly short scarf joint in the middle. The seams were grooved, caulked with moss, with a covering slat and sewn up with yew withes. The bottom planks were further secured by groups of cross-battens passing through cleats left standing on the upper surface of the planks. Part of the first strake survived on one side. It was cut on the curve from the solid wood. No form of framing was discovered, although there were probably at least some thwarts to support the sides of the hull. The meagre archæological evidence at present points to an Early Iron Age date for the deposits in which the boats were found. The botanical evidence may throw further light on their age. The work of recording is now very nearly completed and that of preservation will shortly begin. All being well, these splendid monuments of primitive craftsmanship will in due course be on exhibition at the National Maritime Museum at Greenwich.

An Automatic Computing Engine for the National Physical Laboratory

Following upon Lord Mountbatten's presidential address to the Institution of Radio Engineers, in which he referred to the E.N.I.A.C. (described in an article in *Nature* of October 12, p. 500), a statement was issued from the Department of Scientific and Industrial Research stating that plans for a machine to be called the Automatic Computing Engine (A.C.E.) are being completed at the National Physical Laboratory. A short statement about this machine was broadcast by Sir Charles Darwin, director of the National Physical Laboratory, in the B.B.C. Home Service on November 9. While paper plans have made good progress, the technical design is only beginning, and it will be a year or two before any units are operating. The completion of the machine will take several years. The project is under the charge of Mr. J. R. Womersley, superintendent of the Mathematics Division, and the machine will form part of the Division's equipment. The team of mathematicians who are planning the machine is led by Dr. A. M. Turing, formerly a fellow of King's College, Cambridge, in whose paper "On Computable Numbers, with an Application to the Entscheidungsproblem" (*Proc. Lond. Math. Soc.*, 1937), the possibility of such machines is foreseen, and methods of organising work on them are discussed.

Council for the Preservation of Rural England

In the report of the Council for the Preservation of Rural England, the first after the war years, the aims, objects and policy of the Council are re-stated. Briefly, these relate to the protection of rural scenery, the preservation of amenities in country and town and the education of public opinion on these matters. This comprehensive report gives a clear impression of the many activities which engage the attention of the Council. The policy of the Council, which is discussed at some length, is based on the view that the development of agricultural resources, and the improvement of the social environment of the rural population, provide the best means of realizing the aims of the Council. National and regional planning of the land in the interest of the community is supported; genuine rural industries are to be encouraged, while rural housing and services should be improved. Other sections are devoted to the location of industry and the provision of new towns, road construction, the provision of National Parks and open spaces, afforestation, prohibition of outdoor advertisements in certain localities, and the release of areas from military occupation. In many of these and other matters, the Council for the Preservation of Rural England works in close co-operation with other bodies, for example, the National Trust.

Training Grants for Engineers

The Ministry of Labour and National Service is now awarding grants under the Further Education and Training Scheme to assist young engineers who have been on military service to complete their practical training in industry. University graduates in engineering and others who have qualified as graduates of the Institutions of Civil, Mechanical or Electrical Engineers are entitled to apply for grants. The awards are intended to supplement the payments which employers normally make to engineering graduates. A plan of training must be drawn up by the employer and approved by the Ministry before a grant will be made. Three types of course are contemplated, lasting twenty-four, twelve and six months respectively. The longest course is intended for those who have had no previous industrial experience and only limited technical experience in the Services. The Institution of Electrical Engineers announces that young electrical engineers will be advised to take a twelve-months course if they have had little or no industrial training, but have served eighteen months or more on suitable workshop duties in technical units, or have had 12–18 months previous industrial training and only limited technical experience on military service. Those with more than nine months previous industrial training and more than eighteen months technical experience in the Services will generally be regarded as having completed their training, but some may be advised to take the six-months course. Further particulars may be obtained from the Regional Appointments Officers of the Ministry of Labour and National Service.

Catalogue of Scientific Films in Britain

A catalogue compiled by the Scientific Film Association lists alphabetically 595 films of general scientific interest at present available in Great Britain, ranging from films of technique and process to films relating science to society (London: Association of Special Libraries and Information Bureaux. 5s.) Most films entirely of use for juvenile teaching have been excluded, but some films on cooking and related topics, and selected films on international relations, national cultures, ways of life and tradition have been included to give that social background against which all human activities must be assessed and studied. Of the films listed, 266 have been appraised and graded by special committees, and it is the intention of the Association to supply synopses, appraisals and gradings for every film and to keep the lists up to date in this respect. The graded films are marked recommended, suitable or unsuitable in three categories: for general audiences and audiences of mixed scientific workers; for more specialized audiences with a knowledge of the subject-matter of the film; and for adult teaching or training purposes. Silent films are indicated by printing the title in italic capitals, and sound films with silent versions by an asterisk. Films of which the distribution is restricted for any reason are also marked, and sponsor and production agency, where traced, are indicated. The name of the distributor is usually abbreviated and followed by a catalogue reference for use in ordering. A list of film distributors with these abbreviations is included, and there is a classified subject index.

Association of Scientific Workers: Social Sciences Committee

A meeting to inaugurate a National Social Sciences Committee of the Association of Scientific Workers will be held in Gas Industries House, 1 Grosvenor Place, London, S.W.1, on December 14. The meeting will be held under the chairmanship of Mr. J. R. M. Brumwell. Prof. S. Zuckerman will speak on the outlook for the social sciences, Dr. G. Wagner will report on the work of the Social Sciences Committee, Mr. D. Chapman will discuss future work for social scientists in the Association of Scientific Workers, and Mr. R. Innes will discuss the constitution of a National Committee for Social Scientists. Further information can be obtained from the Honorary Secretary, Social Sciences Committee, Association of Scientific Workers, 15 Half Moon Street, Piccadilly, London, W.1.

Announcements

Sir Alexander Fleming and Sir Howard Florey have been awarded the Gold Medals in Therapeutics of the Society of Apothecaries of London, in recognition of their discovery and work on penicillin.

The title of professor emeritus in the University of Durham has been conferred upon Prof. J. W. Heslop Harrison, formerly professor of botany, and Commander C. J. Hawkes, formerly professor of engineering, both at King's College, Newcastle-upon-Tyne.

Recent appointments to the staff of the University of Leeds include the following: Dr. H. J. Rogers, to be Nuffield Research Fellow in oral biology; Dr. A. B. Moggy, to be Brotherton Research Lecturer in physical chemistry in the Department of Textile Industries; Dr. R. N. Tattersall, to be lecturer (full-time) in medicine.

Dr. E. C. Barton-Wright has been appointed microbiologist to Whitbread and Co., Ltd., and has taken up his duties in the laboratories at Chiswell Street, London, E.C.1.

Referring to the notes under the title "Abnormal Solar Radiation on 75 Megacycles" in *Nature* of October 12, p. 511, Dr. S. E. Williams states that the phrase (par. 2, line 3) "visual changes on the sun's disk as recorded on spectrohelioscope observations . . ." should read, "visual changes on the sun, namely, the appearance of an eruptive prominence recorded in the spectrohelioscope observations . . ."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

G. B. Airy and the Discovery of Neptune

The account by Prof. W. M. Smart of the discovery of Neptune, of which a summary was published in *Nature* for November 9, depicts the part played by G. B. Airy, the Astronomer Royal, in a most unfavourable light. He describes the treatment of Adams by Airy as "unbecoming to the leading astronomer of his generation". Prof. Smart's verdict is not, in my opinion, justified, and I feel that, for the sake of historical accuracy, a reply is needed.

In judging Airy's actions, it is necessary to remember the tremendous load of work which he carried. Besides attending to all the details of the work of the Royal Observatory, he maintained an extensive correspondence with astronomers in all parts of the world and was consulted on a great variety of general scientific questions outside the range of his strict official duties. No man could have been more meticulous in replying promptly to all letters and inquiries. An examination of Airy's day-book shows that in the period covered by the investigations of Adams, Airy visited France for the purpose of examining and reporting upon the design and construction of the breakwater at Cherbourg; he went to York to see experiments on the running of engines; he visited Portsmouth to inquire into and report upon the defects of the engines of H.M.S. *Janus*; he was occupied with the Tidal Harbour Commission and he was frequently called to London for meetings of the Railway Gauge Commission, the draft report of which he prepared.

Airy first learnt that Adams was working on the theory of Uranus from Prof. Challis, who wrote to Airy in February 1844 asking for the errors of longitude of Uranus, as indicated by the Greenwich observations, for the years 1818–26. Airy by return of post sent the Greenwich data not merely for those years, but also for the whole period 1754–1830, data invaluable for the purpose of the investigation.

Adams twice called at Greenwich in the course of his investigations in the hope of seeing the Astronomer Royal and discussing the results he had obtained. It would have been a matter of ordinary courtesy for a young man like Adams, personally unknown to the Astronomer Royal, to have written and asked for an appointment, but Adams on each occasion called without any previous notice. On the first occasion, towards the end of September 1845, Adams called at Greenwich and left a letter of introduction from Challis; Airy was then in France on the Cherbourg breakwater investigation. Immediately on his return, he wrote to Challis and said: "would you mention to Mr. Adams that I am very much interested with the subject of his investigations, and that I shall be delighted to hear of them by letter from him". This letter should surely have encouraged Adams to write. On the second occasion, on October 21, 1845, Airy was in London attending a meeting of the Railway Gauge Commission. Adams left his card and said that he would call later. The card was taken to Mrs. Airy, but the message was not given to her. When Adams made his second call, he was informed that the Astronomer Royal was at dinner; there was no message for him and he went away feeling mortified. This visit is not mentioned in Airy's day-book, and it is clear from Airy's private correspondence that he was not told either of Adams' intention to call again or of his second call. It may also be mentioned that this visit of Adams was made a few days before Mrs. Airy gave birth to a son, Osmund.

Adams left at the Observatory a paper with a summary of his results, and a comparison between the observed longitudes of Uranus and those computed from his theory. On November 5, Airy wrote to Adams putting his famous query about the errors of the radius vector of Uranus. Adams never replied to this letter. In a later letter to Airy of November 18, 1846, he stated how deeply he regretted his neglect and mentioned that he had always experienced a strange difficulty in writing letters. But to a man so methodical and precise as Airy, it was a barrier to any further communication. As Airy afterwards wrote to Challis, "It was clearly impossible for me to write to him again". This is why Adams' statement remained, in Prof. Smart's words, "in Airy's pocket for eight months".

Prof. Smart seems to regard Airy's query as trivial. Airy was, of course, thinking of the possibility that perturbation by an unknown planet might not be the only possible cause of the irregularities in the motion of Uranus. His views were clearly expressed in a letter to Challis (December 21, 1846). "There were two things to be explained, which might have existed each independently of the other, and of which one could be ascertained independently of the other: viz. error of longitude and error of radius vector. And there is no *a priori* reason for thinking that a hypothesis which will explain the error of longitude will also explain the error of radius vector. If, after Adams had satisfactorily explained the error of longitude he had (with the numerical values of the elements of the two planets so found) converted his formula for perturbation of radius vector into numbers, and if these numbers had been discordant with the observed numbers of discordances of radius vector, then the theory would have been false, not from any error of Adams' but from a failure in the law of gravitation. On this question therefore turned the continuance or fall of the law of gravitation."

Prof. Smart mentions that even so late as 1844 Airy regarded as possible that gravitation might not be exactly according to the inverse square of the distance. It is perhaps well to recall that, fifty years later, the same suggestion was seriously examined by Simon Newcomb and other eminent astronomers in the endeavour to explain the anomaly in the motion of the perihelion of Mercury.

It is also stated that towards the end of June 1846 Le Verrier applied to Airy for assistance in the search for the planet, and that this request for practical aid passed unheeded. What were the facts ? Airy had written to Le Verrier putting to him the query about the errors of radius vector which he had previously put to Adams, and had at once received a satisfactory reply. The assurance that the hypothesis of an unknown planet accounted for the errors of both longitude and radius vector of Uranus had convinced him of the reality of the planet's existence. He considered that the telescopes at Greenwich were probably of insufficient size to detect the planet and that the Northumberland telescope at the Cambridge Observatory was the most suitable for the purpose of the search. He therefore wrote to Challis on July 9, 1846, inquiring whether he could undertake the search and, if not, whether he would superintend the examination if Airy supplied him with an assistant from Greenwich for the purpose. He concluded by saying, "The time for the said examination is approaching near".

When Challis informed Airy that he would undertake the search, Airy drew up as a guidance for Challis his "Suggestions for the examination of a portion of the Heavens in search of the external planet which is presumed to exist and to produce disturbances in the motion of Uranus" (dated July 12, 1846). In sending this paper to Challis he wrote, "I only add at present that, in my opinion, the importance of this inquiry exceeds that of any current work, which is of such a nature as not to be totally lost by delay". Airy could not have done more to further the search and to impress upon Challis its urgency. There is little doubt that if the search had been carried out by an assistant from Greenwich, the planet would have been found, for it was an essential part of Airy's system that reduction of observations proceeded *pari passu* with the observations themselves.

As regards the actual researches of Adams and Le Verrier, full abstracts of Le Verrier's investigations had been published in the *Comptes rendus*, but neither Airy nor Challis had received anything from Adams beyond the bare summary of his results; they knew nothing of the methods he had employed.

After the discovery of the planet by Galle at Berlin, Airy wrote to Le Verrier and informed him that collateral researches, which had led to the same result as his own, had been made in England, and that they had been known to him earlier than those of Le Verrier. His "Account of some circumstances historically connected with the discovery of the planet exterior to Uranus" presented to the Royal Astronomical Society on November 13, 1846, left no doubt about the priority of the researches of Adams. In a letter of later date to Biot, Airy wrote, "I believe I have done more than any other person to place Adams in his proper position".

Prof. Smart agrees that the contemporary criticism of Airy, made in ignorance of many of the facts, was on some points unfair and unjustifiable. In my opinion, his verdict that Airy's treatment of Adams was unbecoming is equally unjustifiable.

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THE Astronomer Royal does not see eye to eye with me in my judgment of Airy, in connexion with the Neptune controversy, as expressed in my article in *Nature* for November 9. This article, which was written in response to an editorial request, was a summary of the two addresses—dealing with different aspects of the discovery of Neptune—which I gave at the centenary commemoration on October 8; these addresses were themselves a summary of a fairly long 'essay' (if I may call it so) written at the invitation of the Council of the Royal Astronomical Society and accepted, as I understand, by the Council for eventual distribution to the fellows in one of the Society's publications. The 'essay' is a historical study of events of a century ago, and I was very conscious throughout its preparation that I must follow the methods of the historian as efficiently as I knew how. The job of the historian, as I see it, is to elicit facts, to present these in proper form, and to paint as accurate and complete a picture as possible The 'essay' was accordingly built up on a very large amount of historical documents—I explain in the 'essay' how many of these became available, for the first time, for a study of the Neptune controversy, in which Sir Harold's great predecessor was in many ways the dominant figure

All this, it seems to me, must be said before one turns to the criticism of the Astronomer Royal. Sir Harold's arguments, when documentary evidence is invoked, are based on Airy's letters alone. Most of his quotations will also be found in my 'essay', if—in one or two instances—not as direct quotations then as transcriptions of them. There is no suggestion in my article or 'essay' that Airy was to blame for Adams's failure to see the former on the occasion of his abortive visit to the Royal Observatory in October 1945—it was far otherwise—and as to the famous query about the 'radius vector', Adams never failed to reproach himself for not replying to Airy, although he was convinced that the matter was 'trivial', an opinion shared at the time by Challis.

The main questions are: Why did Airy claim to know the whole history of the business? Why did he declare unambiguously that Le Verrier must be regarded as the real 'predicter' of the planet? Why did he affirm that there was no one (in England) in competition, as regards scientific insight, with Le Verrier, etc.?

It is to be remarked that Airy's correspondence with Le Verrier was understood by him to be 'private', and he was exceedingly indignant—and justly so—when his letters were published in the French press without his sanction being even asked. Later, Airy described Adams as his 'oracle' in all matters relating to lunar and planetary theory; but this has nothing to do with the Neptune controversy as a historical episode. Airy was unjustly criticized on many points, as the Sedgwick correspondence makes abundantly clear, and as I hope my article and 'essay' demonstrate.

Any judgment on Airy's actions must be based, not on his letters alone, but on the whole corpus of contemporary documents. I do not claim that my 'essay' is the last word on the subject, but I do claim that, whatever its faults may be, it was written as a purely historical study with all the implications that this description suggests.

W. M. SMART

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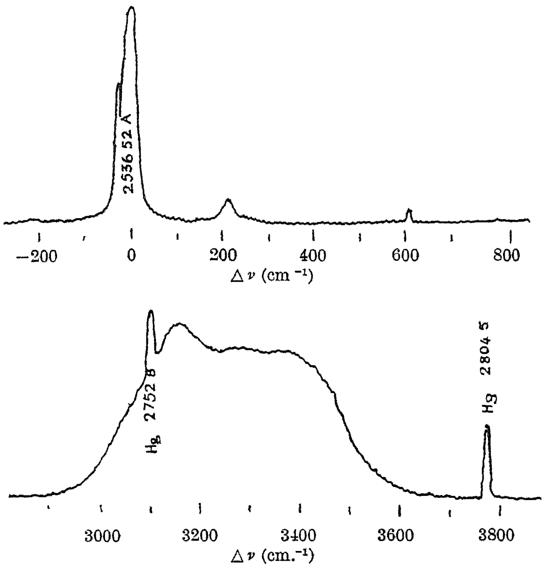
Elastic Constants of Ice

EXPERIMENTS on the thermal scattering of X-rays by ice crystals, made by Dr. K. Lonsdale, have revealed an interesting pattern consisting of strong diffuse bands which extend along the boundary of the second and third Brillouin zone, and to a lesser degree between the fourth and fifth zone. An explanation of this behaviour in terms of atomic vibrations seems scarcely possible. Another feature of ice difficult to explain with the help of vibrations is the Raman effect. A figure representing the Raman scattering of ice according to Cross, Burnham and Leighton[1] is reproduced herewith. Other experiments made by Hibben[2] agree with these in all essential features. One sees that there are two small peaks at about 200 and 600 cm.$^{-1}$, and an enormous hump between 3,000 and 3,600 cm.$^{-1}$. Cross, Burnham and Leighton try to explain this hump as a superposition



Raman effect of ice at 0° C, produced by the Hg line 2536·52 A, according to Cross, Burnham and Leighton. There is no Raman line in the gap between 800 and 2900 cm⁻¹ which separates the two diagrams

of a great number of frequencies due to different 'states of co-ordination' of hydrogen bonds; but this assumption seems to be completely arbitrary, and I doubt whether even the order of magnitude of the range of frequencies can be explained in this way.

In order to clear up these two remarkable observations, I have asked my collaborator, Miss A. H. A. Penny, to make a systematic investigation of the vibrations of the ice lattice. The position of the oxygen nuclei is well known and corresponds to a tridymite lattice. The hydrogens are situated somewhere between the oxygens, but in such a way that two of them are always near one oxygen atom, forming with this oxygen a water molecule. In order to correlate the frequencies with the elastic properties of ice, we first made the simplifying assumption that the hydrogen atoms are in the centre of the line connecting two oxygens. If the forces are considered effective only between next neighbours, one can show by group theoretical considerations that there are six independent atomic constants. We have further simplified the elastic theory by the assumption that the hydrogen atoms surrounding an oxygen atom form a regular tetrahedron. Then one can show either by group theoretical considerations or by using an explicit force law between next neighbours that there are two atomic constants left. The number of elastic constants for a hexagonal crystal is five. Therefore there must be three relations between them. They are too complicated to be reproduced here. We have tried to determine the elastic constants numerically, using the scarce and doubtful measurements on polycrystal ice available[3]. The Poisson ratio seems to be the best known. We took $\mu = 0{\cdot}37 \pm 0{\cdot}01$. The modulus of rigidity can be taken with some confidence to be $N = 1{\cdot}0\ (\pm\ 0{\cdot}1) \times 10^{10}$ dynes/cm.² radian. Strangely enough, the measurements of the compressibility are contradictory. At 0° C., it seems to be in the neighbourhood of $3{\cdot}0 \times 10^{-11}$ cm.²/dynes.

We have used the formulæ given by Voigt[4] for the average values of an isotropic mixture of hexagonal crystals. In this way we could calculate our two atomic constants from two of the measured quantities mentioned above, and we found the third in reasonable agreement. With these constants we found the following values of the true elastic constants of the single crystal: $C_{11} = 4\ 92$, $C_{12} = 2{\cdot}95$, $C_{13} = 2{\cdot}67$, $C_{33} = 5{\cdot}20$, $C_{44} = 0{\cdot}88$. Each constant is multiplied by 10^{10} and measured in dynes/cm². We suggest that accurate measurements with supersonics ought to be made on ice monocrystals using a method like that of Bhagavantam and his pupils[5] in order to check these values.

Accepting the two atomic constants, we can now calculate the first-order Raman effect. We find two frequencies $\nu_1 = 172$, $\nu_2 = 718$ cm.⁻¹ which agree fairly well with the two small peaks visible in the diagram. It seems, therefore, that these correspond to the elastic reaction of the lattice calculated by replacing the real positions of the hydrogen atoms by fictive mean positions.

I do not think that a broad hump like that revealed by the experiments can be explained by small vibrations at all, and I suggest the following explanation. The hydrogen atoms exchange their positions by finite jumps from the neighbourhood of one oxygen atom to that of another, in such a way that there are always two hydrogen atoms near an oxygen atom. One can express the same assumption also by saying that the water molecules jump from one of the six orientations available in each lattice point to another. I have succeeded in showing that finite transitions of this kind produce a continuous X-ray pattern depending on temperature. It is essentially determined by the correlation coefficient of the orientation of two neighbouring water molecules. It is probable that this explanation will also account for the broad Raman band. Investigations on this question are in progress.

MAX BORN

Department of Mathematical Physics,
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Nov. 4.

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[2] Hibben, J H., *J. Chem. Phys*, 5, 166 (1937)
[3] Dorsey, N. E, "Properties of Ordinary Water-Substance" (Reinhold Publishing Corporation, New York).
[4] Voigt, W, "Lehrbuch der Kristallphysik" (Teubner, Leipzig)
[5] Bhagavantam, S., and Bhimasenachar, J, *Proc. Ind Acad Sci.*, 20, 298 (1944)

Use of the Electrolytic Tank for Magnetic Problems

IT is well known that a convenient method for obtaining the solution of problems of potential theory is to make a model in a water tank in which the equipotentials of the real problem are represented by equipotentials, conductors by conductors and field intensity by current density. Charges, that is sources in the real field, are represented in the model by sources of current, namely, electrodes. This model is satisfactory for any problems involving a vortex-free, but not necessarily source-free, field.

If the problem is that of the magnetic field produced by conductors carrying currents, we have a source-free, but not vortex-free, field. In this case lines of force will in general be closed circuits, and the direct representation of this in the model, as stated, is evidently impossible.

It does not seem to be generally known that, for two-dimensional problems, a convenient procedure is to use the conjugate problem, in which the roles of lines of force and equipotentials are interchanged. This leads to a model in which the lines of force of the real problem are represented by equipotentials, iron (if idealized to have infinite permeability) by an insulating substance and conductors carrying a current at right angles to the plane of the problem, by electrodes. If the net current in the real problem is not zero, the net current from all electrodes in the model is unequal to zero, and the excess should flow to or from infinity. In practice, it is sufficient to make the sides of the tank conducting, and use them as an extra electrode if the tank is of generous dimensions.

If the conductors in the real problem are of finite cross-section, with a continuous current distribution, an approximation is necessary, using in the model a number of fine wires as electrodes, adjusting either the distribution of the wires or the current supplied to each of them. The spacing of the wires should be small enough to ensure that the error introduced by the discontinuous distribution is not excessive. This error can be estimated by calculation, or by repeating the model experiment with a larger spacing, say, leaving out every second wire.

The diameter of the wires must be reasonably small, so that the distortion of the field by the images formed in them becomes negligible.

This note arises from an interesting discussion with Mr. K. J. R. Wilkinson, of the British Thomson-Houston Co., Ltd., and Mr. J. S. Gooden.

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Nov. 6.

Disintegration of Magnesium and Aluminium by Deuterons

THE nuclear masses of the elements between neon and silicon in the Periodic Table are known with much less accuracy than those of lighter elements. In order to check the values given in the most recently published tables[1], we have studied the emission of protons from magnesium and aluminium under deuteron bombardment at 900 kV. The protons were observed at right angles to the deuteron beam: the experimental technique employed has already been described[2].

The proton groups obtained from magnesium targets are shown in Fig. 1. No search was made for groups of range less than 16 cm. because of the presence of strong contamination groups. We attribute Groups I, II and VI of Fig. 1 (mean ranges 15·8, 21·5 and approximately 52 cm.) to deuterium, nitrogen and carbon contamination respectively, since they appeared with blank targets and have the ranges to be expected from the reactions $^{2}D(d,p)^{3}H$, $^{14}N(d,p)^{15}N$ and $^{13}C(d,p)^{14}C$. Groups III, IV and V, of mean ranges 30·85, 35·4 and 42·2 cm., appear to come from magnesium, and might arise from any of the three isotopes. The ranges to be expected from the published mass values are: $^{24}Mg(d,p)^{25}Mg$, 37 cm.; $^{25}Mg(d,p)^{26}Mg$, 121 cm.; $^{26}Mg(d,p)^{27}Mg$, 29 cm. It therefore appears plausible to assign Group IV to the reaction $^{24}Mg(d,p)^{25}Mg$, and Group III to $^{26}Mg(d,p)^{27}Mg$. We have checked that magnesium targets after bombardment show

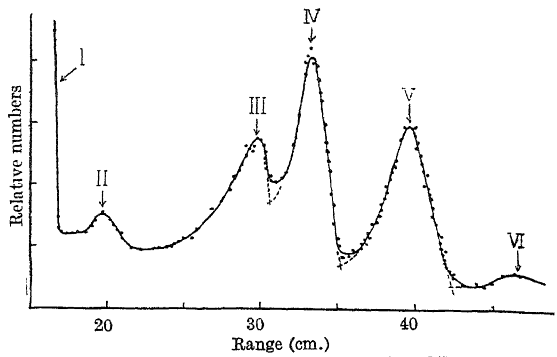

Fig. 1 PROTONS FROM MAGNESIUM (900 kV)

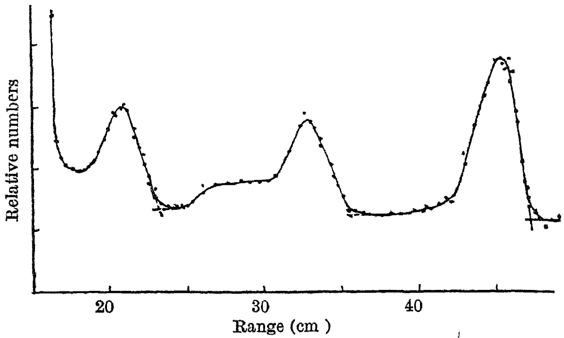

Fig. 2. PROTONS FROM ALUMINIUM (900 kV.)

the 10-minute β^--activity characteristic of ^{27}Mg[4], and that the amount of activity is in rough agreement with that to be expected from the number of protons in Group III. On these assumptions, Group V cannot arise from either ^{24}Mg or ^{26}Mg. We have made an unsuccessful search out to 130 cm. for any other proton group which might be allocated to the reaction $^{25}Mg(d,p)^{26}Mg$, and therefore make the tentative assumption that Group V arises from this reaction, but that the ^{26}Mg nucleus is formed in an excited state, with energy some 5 MeV. above the ground-state. Groups corresponding to excited states at 1·85 and 3·00 MeV., as reported by Pollard[5], were not detected.

Our results on the disintegration of magnesium by deuterons may be summarized as follows:

	Mean range of protons (cm.) (deuteron energy 900 kV.)	Q-Value (MeV.)
$^{24}Mg(d,p)^{25}Mg$	35 4 ± 0 4	4·49 ± 0·05
$^{25}Mg(d,p)^{26}Mg^*$	42 2 ± 0·4	5·05 ± 0·05
$^{26}Mg(d,p)^{27}Mg$	30 85 ± 0·4	4·08 ± 0·05

Fig. 2 shows the proton groups obtained from aluminium under deuteron bombardment. Here only one isotope is involved, and the groups presumably all arise in the reaction $^{27}Al(d,p)^{28}Al$. The mean ranges (for deuteron energy 900 kV.) and Q-values are:

23·4 ± 0·4 cm	Q = 3·34 ± 0·05 MeV.	excited states
35·7 ± 0·4 cm.	Q = 4 49 ± 0·05 MeV.	excited states
48·0 ± 0·5 cm.	Q = 5·49 ± 0·06 MeV.	ground-state

These values are in rough agreement with those found by other workers[6,7].

We have attempted to use our results to build up a set of mass values for the elements between neon and silicon, by the procedure of Livingston and Bethe[3]. The method is based on the following sequence of reactions:

(a)	$^{23}Na(d,\alpha)^{21}Ne$	$Q = 6\cdot75 \pm 0\cdot1$	MeV.[8]
(b)	$^{23}Na(d,p)^{24}Na$	$Q = 4\cdot76 \pm 0\cdot1$	MeV[8]
(c)	$^{24}Na \xrightarrow{\beta+\gamma} {}^{24}Mg$	$Q = 5\cdot53 \pm 0\cdot22$	MeV[9]
(d)	$^{24}Mg(\alpha,p)^{27}Al$	$Q = -1\cdot8$	MeV[3,10]
(e)	$^{27}Al(d,p)^{28}Al$	$Q = 5\cdot50 \pm 0\cdot06$	MeV
(f)	$^{28}Al \xrightarrow{\beta+\gamma} {}^{28}Si$	$Q = 5\cdot03 \pm 0\cdot23$	MeV[11]

From the most recent Q-values, given above, the change in mass defect between ^{21}Ne and ^{28}Si is found to be $(15\cdot1 \pm 0\cdot5) \times 10^{-3}$ mass units, whereas the mass spectrograph values quoted by Aston[12] give $(13\cdot1 \pm 0\cdot7) \times 10^{-3}$ mass units. The difference may be due to errors distributed among the Q-values of all the above reactions, although those most open to doubt appear to be (d) and (f).

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Rate of Spread of Discharge Along the Wire of a Geiger Counter

IN 1939, one of us[1] made a determination of the half-life of thorium C′ as 2×10^{-7} sec., using a coincidence technique with variable resolving time. It was found, however, that delays were occurring in the system of the same order of magnitude, and these could only be attributed to the Geiger counters. The outbreak of war prevented any further work until now; but in the meantime there have been published several important papers on the subject of Geiger counters[2,3,4]. In particular, Stever[5] observed that a small bead on the wire of a self-quenching counter prevented the discharge spreading down the wire, and reported that Brode had shown that the discharge did not travel instantaneously.

It was decided to redetermine the period of thorium C′ and at the same time make an investigation of the delays in self-quenching counters. Random delays in counters have usually been attributed either to the time of build-up on the Townsend avalanche or to the time taken for the electron produced by the initial ionization to travel to the intense field around the counter wire. If, however, the time taken for the discharge to travel down the wire is considerable compared to the time intervals under consideration, we would expect the rate of build-up of charge on the counter wire to depend upon whether the discharge spreads from one end of the counter, or spreads

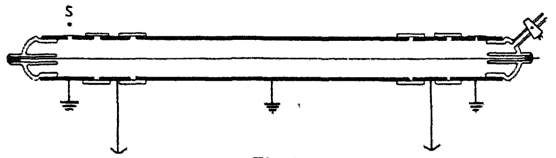

Fig. 1

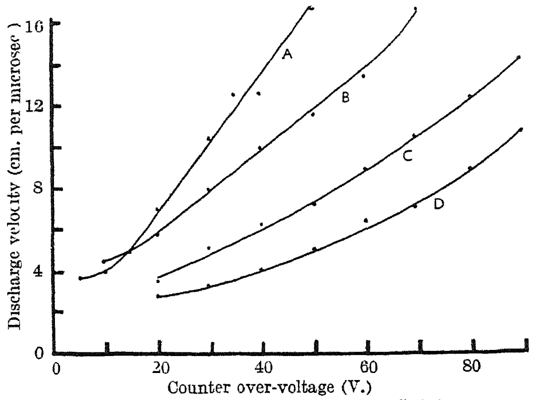

Fig. 2. A, 2·5 cm argon; B, 9·5 cm helium; C, 4·5 cm. argon; D, 9·5 cm argon. All with 0·5 cm alcohol

in both directions from some place in the middle of the wire.

Three sets of experiments were made by a combination of delay line and coincidence techniques, thereby avoiding the use of extremely narrow pulses and separating the effects of random delays from those of fixed delays occurring in one arm with respect to the other. First, observations were made on β–γ coincidences from a source where there was no reason to expect a γ-ray life-time approaching 10^{-7} sec. Delays were observed of the order of 10^{-7} sec.; and these decreased with increasing over-voltage. Secondly, a twin counter was built in which a narrow open slit was left joining the two counters, the slit being in the plane of the two wires. β-particles were fired through a window in one of the counters and could actuate both counters only if they passed close to each wire. The delays observed were similar to those observed in the β–γ coincidence experiment. (There was no tendency for one counter to cause actuation of the other, despite direct optical and gaseous path between them.) The third experiment to measure the rate of spread of discharge along the wire of a counter made use of counters consisting of a single wire but with the cathodes cut into several sections (Fig. 1), the portions of the cathode connected to earth being used as A.C. guard rings between the two portions connected to the timing circuit. The discharge could be initiated by means of a β-ray source opposite one of the windows at the ends of the counter. Measurements of the time intervals between the pulses produced on the two cathodes were made, first using the delay line coincidence circuit with a counter 4 cm. long, and later by means of a high-speed triggered oscilloscope on a counter 100 cm. long.

Fig. 2 indicates the variation of propagation velocity for different over-voltages and gas fillings in a counter having a wire diameter of 0·008 in. and a cylinder diameter of ⅞ in., and having 5 mm. pressure of alcohol as the quenching vapour in each case.

The mechanism by which the discharge spreads down the wire has not yet been fully explained; but it would seem that it must be due either to the emission of photons causing further ionization before they can be adsorbed by the alcohol or possibly the positive ions being accelerated in the direction of propagation of the discharge by the distortion of the field at the edge of the ion sheath. From the few measurements taken so far, it appears that the speed of propagation is affected only slightly by the alcohol concentration, but markedly by changing the pressure of the argon gas or by replacing it by helium. This would seem to discount the possibility of photons taking an active part in the discharge in a self-quenching counter.

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A New Type of Diffusion Cell

THE well-known metal diffusion cell with slide constructed by Lamm[1] has been used almost exclusively during the last ten years for accurate determinations of diffusion constants. However, as Lamm points out, it is difficult to tighten this cell in experiments with organic solvents; in such cases cylindrical diffusion tubes of glass are mostly used, making it difficult to take full advantage of the great accuracy obtained with the Lamm scale method.

A new type of diffusion cell will be described here which can be used both for water solutions and organic solvents. The cell has the shape shown in Fig. 1. It is made from stainless steel plate (10 mm. thickness) which is enclosed between two glass disks held in position by frames and screws. The piece A is moved by the eccentric arrangement B and slides between the two windows. It is held against the bottom plane by the spring S. When the cell is in use, the denser liquid (the solution) is filled through the hole D,E into the lower part of the cell proper (G) and thereafter the piece A is moved to close G. Then the cell is filled *up to the level* N with the lighter liquid (the solvent) and the hole E is closed with a screw stopper. The cell is then put into the thermostat and the diffusion started by moving the piece A back to the position shown in Fig. 1. Diffusion takes place in the cell proper (F,G), and no leaking can occur *as there is the same liquid in* F *as outside at* H. No grease or other sealing agent is needed on the piece A as the increase in density in F during the diffusion process is much too small to force the solution out into H. During the experiment, the glass tube (R) for the key to the eccentric arrangement is closed by a glass stopper. It is seen that the boundary-forming arrangement here is of the same type as in Tiselius' electrophoresis apparatus; extremely sharp boundaries are obtained in this way. The cell is, furthermore, simple to manufacture and consists of only three metal pieces. It is consequently easy to clean.

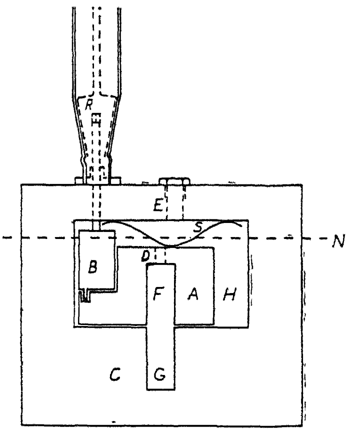
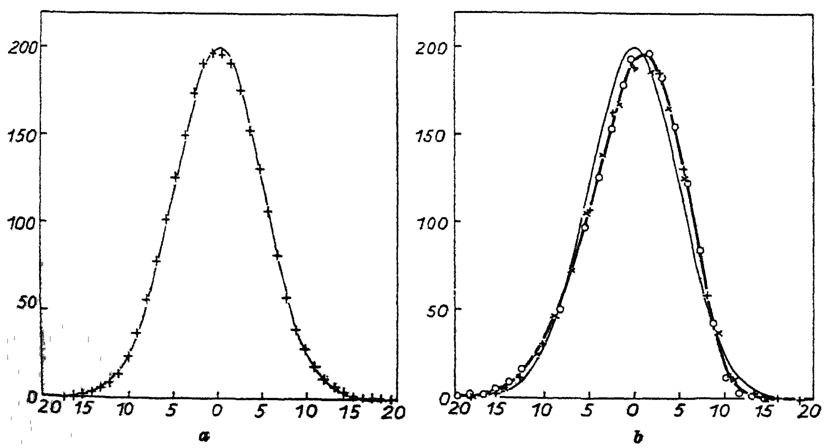


Fig. 1. DIFFUSION CELL

Hæmocyanin (*Helix pomatia*) 0 25%	0 08 M acetate buffer	pH=6 2, 0 2 M NaCl Temp 20° C.
Time (sec)	D_A 10⁷	D_m 10⁷
142,000	1 16	1 13
179,000	1 15	1 12
226,000	1 12	1 10
257,000	1 10	1 12
Mean	1 13	1·12
Nitrocellulose 0 40% in acetone solution. Temp. 20° C.		
50,200	2 76	2 53
81,400	2 80	2 97
112,000	2 61	2 34
129,000	2 68	2 65
168,000	2 78	2 56
Mean	2 73	2 61

By making more than one pair of slots in the pieces A and C several experiments can be performed at the same time provided that the solvent is the same. A cell with three pairs of slots (instead of only F,G) has been used for some time at this Institute. The interval (12 mm.) between the three cells is then so small that one fixed camera can be used, and the only alteration from the standard equipment is that one scale is needed for each cell proper.

The cell has worked well both for substances with small and great diffusion constants (hæmocyanin, sodium chloride) and with different solvents (water, acetone). Only the diffusion curves in normal co-ordinates will be given here for hæmocyanin (Fig. 2,a) and for nitrocellulose with a skew diffusion curve (Fig. 2,b). The curves are completely satisfactory, and the diffusion constants calculated from



a *b*

Fig. 2. DIFFUSION CURVES IN NORMAL CO-ORDINATES
(*a*) Hæmocyanin. (*b*) Nitrocellulose; the thin line is the normal frequency curve

exposures at different times are given in the accompanying table.

I wish to express my thanks to Prof. The Svedberg for his interest in this work.

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Computation of Biological Assays

In microbiological assays of essential amino-acids, and of members of the vitamin B_2 complex other than riboflavin and nicotinic acid, it is usually found that when the mean responses are plotted against either the dose or the logarithm of the dose, a non-linear relationship is obtained. It has been customary to compute the result in such cases by the direct-reading method, which from the statistical point of view is unsatisfactory in more than one respect, while further examination of the data is difficult or impossible.

On examination of the protocols of several assays by various workers (to whom acknowledgment will be made elsewhere), I find that in most cases the results are fitted well by a straight line, at least over a reasonable range, when the logarithm of the response is plotted against the logarithm of the dose. As an example, reference may be made to a tryptophan assay, the standard curve for which has been published by Barton-Wright[1]. The experimental data plotted in the manner just described are linear over a dosage range of 2–12 μgm., or 3·75–12 6 ml. in terms of response.

This 'log-log' transformation provides, for those assays which conform to it, a method of computation which is both sound and simple. The formulæ are precisely the same as in the case, well known in macrobiological assays, in which the response is linearly related to the logarithm of the dose, except that the logarithm of the response is used instead of the response itself. The test and standard lines when plotted on the same graph should theoretically be found to be parallel; a significant departure from parallelism renders the validity of the assay suspect; and the best estimate of the potency-ratio of the two preparations is obtained from the horizontal distance between the two lines.

Fuller details with illustrative examples will be published later. I should be very interested to receive reports from workers in this field who may test the applicability of the 'log-log' relationship to their own assays. There are further implications which concern the *design* of assays of this type—for example, doses should be in geometrical rather than arithmetical progression—but this cannot be discussed here.

May I take this opportunity of pointing out that in my previous communication in *Nature*[2] about assays in which the response is linearly related to the dose, I neither claimed nor intended to claim that the slope-ratio method of computing them was original. Bliss and Cattell, in a review article[3] published in **1943**, quote three instances of biological assays in which the dose is linearly related to the response. They point out that the slope-ratio method should be used, and add: "such assays are exceptional and their statistical treatment has yet to be described". The best known of the assay techniques they quote is the bradycardia method for aneurin as developed by Harris and his co-workers, the earliest of whose papers is dated 1934[4]. More recently, Dr. M. Kerly, in a paper on the riboflavin content of canteen meals[5], calculated some of her results by the slope-ratio method; her stated reason for doing this is that the line through the test observations did not pass through the 'blank', although the standard line did—an indication that the result may have been statistically invalid. It is clear, however, that the degree of invalidity is not large, and it is a point in favour of the slope-ratio method that the results calculated in this way were found in the three cases in which they were checked by the rat-growth method to be in satisfactory agreement therewith.

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Nov. 8.

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Surface Charge of 'Electrets'

Certain dielectric materials, if solidified from the molten state in a strong unidirectional electric field, are known to remain in a polarized condition for considerable periods of time and, under certain conditions, surface charges as high as 5 E.S.U./cm.^{2} are retained for several years[1–4]. The materials generally used for the preparation of these so-called 'electrets' are mixtures of carnauba wax and colophony, or carnauba wax, colophony and a small proportion of beeswax.

Several interesting effects have been observed by following the variation with time of the charge on the cathode and anode layers of electrets, these being the surfaces which were adjacent to the negative and positive electrodes, respectively, during preparation. These effects appear to have escaped notice previously, attention having generally been confined to variations in the charge of the cathode layer only.

The preparation consisted in allowing different types of dielectric materials to solidify in a field of approximately 10,000 v./cm., between two parallel metal electrodes, the tension being maintained for about two hours. When the dielectric had cooled to room temperature, the electrodes were connected to earth for some time to remove temporary surface charges. The samples were then withdrawn, wrapped in tin foil and stored over calcium chloride in a desiccator. Measurements of the surface charges were taken from time to time using a Lindemann electrometer.

Fig. 1 shows typical curves obtained for electrets prepared from two different qualities of prime yellow carnauba wax. It is seen that shortly after the rapid transition from a hetero- to a homo-charge, the anode layer assumes a short-lived high positive charge; this subsides rapidly to the steady lower charge, which is retained for some time.

In the case of colophony, the charges on the cathode layer were invariably lower and decayed more rapidly than those on the anode layer, when metal electrodes were used in the preparation (Fig. 2, *A*). It is possible that this is due to interaction between the dielectric and the electrodes, or between

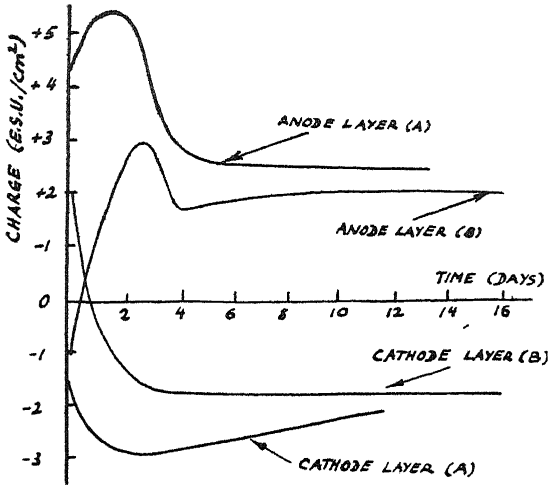

Fig 1. CHARGE-TIME CURVES. CARNAUBA WAX

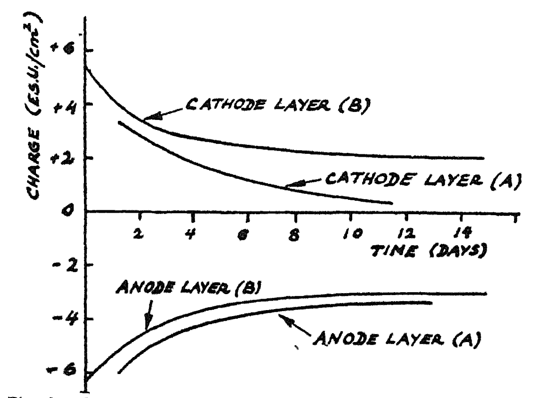

Fig. 2. CHARGE-TIME CURVES. COLOPHONY. (*A*), ALUMINIUM ELECTRODES; (*B*), ELECTRODES LINED WITH 'CELLOPHANE'

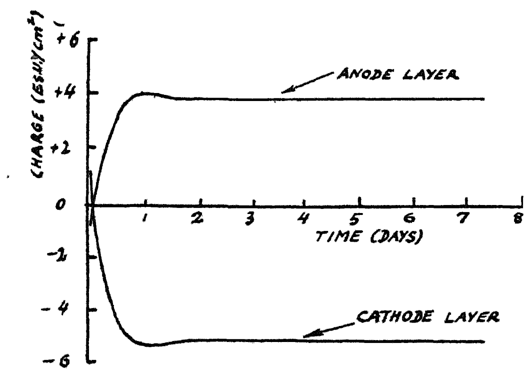

Fig. 3. CHARGE-TIME CURVES. MIXTURE OF COLOPHONY AND CARNAUBA WAX

the electrodes and some surface impurity. By the use of metal electrodes lined with dry 'Cellophane', a marked increase in the charge of the cathode layer was obtained (Fig. 2, *B*).

Fig. 3 shows the time variation of the charges in an electret prepared from a mixture of equal weights of colophony and carnauba wax, using tin electrodes. The resultant negative charges are seen to exceed somewhat the positive ones, an effect due to the colophony component.

The quality of the materials used, especially the carnauba wax, was found to be of some importance. Mixtures containing fatty grey carnauba wax, which is obtained from older plants than the prime yellow variety, or slightly inferior grades of the prime yellow wax, attained only comparatively low charges.

A fuller account of the work will be published later.

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Function of Bacterial Polysaccharides in the Soil

MOST aerobic micro-organisms such as *B subtilis*, *B. megatherium*, *Leuconostoc* species, Rhizobia, etc., are capable under favourable cultural conditions of producing highly viscous polysaccharides either as heavy capsular material or as extracellular products. Apart from their role in the defensive mechanism of the micro-organism against soil Protozoa, etc., little is known regarding the function of microbial-polysaccharides in the soil.

In view of the highly mucilaginous nature and high chemical stability of some of these complex carbohydrates, it occurred to us some years ago that they might play an important part in conserving the moisture content of soils and clays. Accordingly, investigations were begun along three lines: (1) an examination of the moisture, total carbohydrate and polysaccharide contents of rich and poor soils and clays from different localities; (2) the influence on the moisture-conserving capacity of light soils of the addition of known bacterial polysaccharides; (3) the determination of the effect, on soil microflora, of known concentrations of sugars and hexose phosphates particularly in respect of polysaccharide production and of the moisture-binding capacity of various soils.

Project (1) was carried some distance before the work had to be suspended for other urgent work. By extracting soil with buffers, followed by the usual methods for isolating polysaccharides, it was shown that poor soils with a low content of organic matter contained traces only of polysaccharide material. On the other hand, those soils with a high content of organic matter contained significant amounts of polysaccharide (for example, 1 kgm. of moisture-free soil gave 0·5–1·5 gm. polysaccharide) and in general possessed a greater moisture-retaining capacity. From various soils there were isolated polysaccharide fractions having rotations varying from $[\alpha]_D + 20°$ to $[\alpha]_D - 80°$, from which in most cases levans ($[\alpha]_D - 90°$) could be separated. The products usually gave viscous solutions in water and had nitrogen contents of 0·3–0·5 per cent.

In regard to projects (2) and (3), it was shown that the addition of viscous bacterial mucopolysaccharide particularly of the dextran type (nitrogen contents c. 0·3–0·5 per cent) have an important effect on the moisture-binding capacity of soils. The nature of the free sugars in the soils is also of high significance. This is particularly so in regard to the presence of sucrose in soils, without which levan and dextran formation cannot proceed. Extracellular synthesizing enzymes under appropriate conditions can function in the soil at distances remote from the microbial cell, and build up complex hydrated polysaccharide structures from sucrose and the hexose phosphates. It is hoped to continue and extend these investigations.

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Influence of Bacterial Polysaccharides on Aggregate Formation in Soils

It has long been assumed that micro-organisms play an important part in producing a crumb or aggregate structure in soil, and it is known that following the addition of sucrose to soil there is a marked development of water-stable aggregates.

At Jealott's Hill, we have been studying the effect of bacterial polysaccharides of the levan and dextran types on the binding of soil particles. While this investigation was in progress, we became aware of work going on along similar lines at the University of Birmingham (see preceding letter) and in the United States[1].

We have studied the aggregation of soil by the wet sieving technique and were able to show that the addition of washed bacterial cells, for example, those of *B. subtilis*, had very little aggregating effect.

When *B. subtilis* was cultured in a sucrose medium there was gum production; and following dialysis, removal of the cells, and concentration of the solution, etc., alcoholic precipitation gave a white product which was a levan (nitrogen content, 0·2–0·3 per cent; 97–98 per cent fructose after hydrolysis (cf. Martin[1])). By using different culture media and methods of extraction, levans having varying nitrogen contents could be obtained from *B. subtilis*, and the significant discovery was made that whereas those products containing 0·2–0·3 per cent nitrogen had a marked aggregating effect on soil, those with a nitrogen content of less than 0·1 per cent had but little action. Further, it was observed that both the nitrogen content and the aggregating effects were related to the relative viscosity of the levan solution.

The polysaccharides capable of aggregating soil appear to be very similar to, or identical with, those polysaccharides which show antigenic activity. Thus it will be recalled that polysaccharides appear to owe certain of their immunological properties to the presence in them of a nitrogenous constituent; for example, Fitzgerald[2] from serological studies found that the antigenic activity of a polysaccharide produced by *L. mesenteroides* disappeared when its nitrogen content was reduced to less than 0·2 per cent. In this connexion Stacey[3] has suggested that dextrans and other polysaccharides in their most natural state consist of polyglucose chains 'cemented' together by units of the synthesizing enzyme which remains as an integral part of the complex mucopolysaccharide. The levans we have examined may possibly consist of polyfructose chains held together in a similar way.

Microbial polysaccharides are probably only one of the groups of metabolic products having an ameliorative effect on soil structure. However, since the diverse microflora of soil may synthesize many types of polysaccharides from the constituents of vegetable remains, we wish to point out the importance to soil of this group and to emphasize that a knowledge of the chemistry of microbial products would do much to elucidate the composition and functions of humus in the soil.

We are indebted to Profs. Haworth and Stacey for the supply of a number of levans and a dextran

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Role of Sulphydril Groups in the Action of Acetylcholine and Inhibition of the Vagus Nerve

Work on the chemical constitution and fine molecular structure of protein bodies has appreciably advanced our knowledge of the nature of the process of the reversible denaturation of protein bodies, which underlies a number of fundamental biological phenomena, including those of muscular contraction.

In particular, the work done in this domain has demonstrated the important part played in the processes of denaturation of protein bodies by the sulphydril groups. As the chemical groups of side-chains of protein bodies, endowed with particular activity, the sulphydril groups are not only likely to participate in processes of direct structural alterations of certain protein bodies, probably including myosin[1,2], but also, as active groups of the protein component of definite enzymes, they participate in a number of fermentative processes invariably attending the complex phenomena of reversible denaturation of protein structures under the conditions prevailing in a live cell. Among the enzymes the activity of which is dependent upon the sulphydril groups we find more than one playing a most important part in carbohydrate metabolism, in particular in that accompanying the enzymic transformations of pyruvic acid[3], and also in cholinesterase[4].

On account of the paramount importance of the enzymes of carbohydrate metabolism and of the enzyme cholinesterase in the course of synthesis and breakdown of acetylcholine, and accordingly that of the relation between the 'acetylcholine cycle', and the 'adenyl cycle'[5], which is intimately connected with the reversible denaturation of the contractile protein of myosin and the general chemodynamics of the muscle in the process of excitation, we endeavoured to find out the role of the sulphydril groups in the action of acetylcholine and nerve stimulation upon the cardiac muscle.

To examine the possible role of the sulphydril groups in nerve stimulation and of physiological doses of acetylcholine, we have tested the effect of stimulation of the vagus nerve and that of acetylcholine upon the cardiac muscle of the frog when the sulphydril groups are bound, followed by the introduction of these groups. As a substance likely to bind the sulphydril groups, use was made of a solution of mercury bichloride (1×10^{-3}, 1×10^{-4}), which is known to form with the sulphydril groups a mercaptide bond; as a donator of the sulphydril groups, cystein was applied (2×10^{-3}).

Our experiments, carried on in a large number of replications, led to the following conclusions. The clearly pronounced inhibitory effect on rhythmical contractions of the heart muscle, due to the action of the vagus nerve and of acetylcholine, was found to be removed after the application of mercury bichloride solution, that is, after binding the sulphydril groups, as a rule, the effect was restored after the heart was washed with cystein solution. In control experiments, no similar action could be obtained with Ringer or cystein solution.

When the mercury bichloride solution was introduced against a background of the influence of acetylcholine, that is, when the contractile substrate and the corresponding chain of enzymo-chemical processes was subjected to the influence of acetylcholine, but the phase of restoration had not yet begun, the mercury bichloride solution was no longer able to cause the effect recorded by us: after the normal height of the contractions has been restored, every application of acetylcholine was followed by a typical effect of inhibition of the rhythmical contractions of the heart. This effect vanished as a rule in all experiments in which mercury bichloride was applied against a background of normal contractions.

Preliminary experiments have shown that, unlike the effect of mercury bichloride, the well-known effect of elimination of the action of acetylcholine with atropine cannot be restored with cystein, which points to a peculiar biochemical mechanism underlying the action of atropine.

Experiments in this direction are in progress.

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Specific Action of Optical Isomers of Mepacrine upon Dextral and Sinistral Strains of *Bacillus mycoides* Flügge

THE normal colonies of *Bacillus mycoides* Flügge growing on the surface of agar medium have filaments with an anti-clockwise spiral and should be called sinistral or *L*-forms; there occur also as very rare exceptions colonies with a clockwise spiral (dextral or *D*-forms).

Our cultures (two *D*-strains and two *L*-strains) were obtained from Prof. E. N. Mishustin (Institute of Microbiology, Academy of Sciences of the U.S.S.R.). Three of them were isolated from soils collected in the vicinity of Lake Sewan, Armenia. Optical isomers of mepacrine hydrochloride were prepared at the Institute of Malaria and Parasitic Diseases according to the method of Chelinzev and Ossetrova[1]. *Bacillus mycoides* was cultivated on a medium with 3·5 per cent of German agar in a potato broth (200 gm. of potatoes boiled for 30 min. in 1,000 c.c. of water). Mepacrine was added to the hot medium, which was again heated on the following day up to boiling point in a water-bath, or autoclaved Throughout all experiments (with one exception) 0 01 per cent of mepacrine in the medium was used. This concentration causes approximately a 30 per cent depression of colony growth. Each 10-cm. Petri dish received four point inoculations. The diameter of the colonies was measured after 24, 48, 72 or 120 hours from the beginning of growth, by means of dividers. As a measure of the relative toxicity of dextro- and lævo-rotatory mepacrine an index (d/l) 100 was taken, where d represents the average diameter of four colonies grown on a medium with d-mepacrine, and l that of colonies grown in the presence of l-mepacrine.

Seven experiments were carried out. Omitting the third experiment, in which there were some defects in the preparation of the medium, in all experiments the index for dextral colonies was lower than for sinistral ones (74·4 as against 114·1 per cent). The difference between the indices is statistically significant, being equal to 6·51 with five degrees of freedom. A contingency table for the direction of the spiral and the value of the index lying below and above 100, using the Yates–Fisher adjusted formula, gave $\chi^2 = 17 \cdot 15$, with a probability much below 0·01. This can be considered as a proof of the existence of a relation between the direction of the spiral and of the value of the index. We may conclude that the two forms of *B. mycoides* are characterized not only by an inversion of colonial morphology but also by an inversion of some mepacrine 'receptors' on a molecular level.

According to previous investigations in our laboratory all living organisms, beginning with normally spiralized or *L*-forms of *B. mycoides* and Infusoria up to higher Vertebrata[2], show an index greater than 100. This means that their living matter is less sensitive to d-mepacrine than to l-mepacrine. The only exception to this rule known at present is the dextral form of *Bacillus mycoides* Flügge, which evidently originated by mutation from the normal sinistral form. Gause[3] succeeded in showing that the *D*-form of *B. mycoides* contains an enzyme which can split unnatural dipeptides (of dextral steric series). In connexion with this, one must keep in mind that Kögl and Erxleben[4] have isolated from malignant tumours the unnatural isomer of glutamic acid (of dextral steric series), and Waldschmidt-Leitz and Mayer[5] have discovered in the blood serum of patients with malignant tumours enzymes of unusual stereochemical structure. Taking all these facts into consideration our experiments with *D*- and *L*-strains of *B. mycoides* perhaps represent a first step towards developing a rational cancer therapy utilizing optical isomers. Drugs similar to d-mepacrine inhibiting the growth of cells containing substances with abnormal molecular configuration more strongly than that of cells with normally configurated molecules might perhaps be useful in depressing malignant cell-growth in the animal and human body.

This work was carried out in collaboration with my assistant, Mrs. O. C. Nastukova.

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Effect on some Blood-sucking Arthropods of 'Gammexane' when Fed to a Rabbit

THE physiology and nutrition of the bedbug (*Cimex lectularius*) has been the subject of investigation in this laboratory for a number of years. A preliminary report has been published[1], and a paper dealing with the matter more fully is in the press. One of the problems we have set ourselves is to make the blood of the host unsuitable for the bedbug by altering it in one way or another. The ultimate aim was to find some substance, non-toxic for the host, which when fed to animals would kill or control bedbugs and other blood-sucking arthropods. Numerous attempts in this direction, with a wide variety of materials, have been made, and some success has been obtained. Recently, through the kindness of Dr. W. C. Walmsley, of African Explosives and Chemical Industries, Ltd., Northrand, a few grams of the pure gamma isomer of hexachlorocyclohexane was obtained. Results with this substance have been so striking that it has been considered of interest to make them known immediately.

The 'Gammexane' was powdered and mixed with a solution of agar. The agar, when set, was cut into portions each of which contained approximately 50 mgm. One of these portions was fed to a rabbit weighing 1,730 gm. every morning. The arthropods, from known healthy stocks, were confined in glass tubes, covered with gauze, and placed on the rabbit's ear. In the case of the mosquitoes, a small gauze cage was applied to the shaved side of the animal.

Toxic effects on blood-sucking arthropods became evident on the second day, that is, after the rabbit had taken a total dose of 100 mgm. of 'Gammexane'. It will be convenient to give the results of experiments done after a total dose of 200–250 mgm. of 'Gammexane' had been given to the rabbit.

Cimex lectularius. Feed fully in all stages and show signs of paralysis immediately after feeding. First-stage nymphs were given their first meal on the 'Gammexane' rabbit, subsequent instars were reared to each particular stage on a normal animal and then fed on the 'Gammexane' rabbit. The mortalities, within 24 hours, for each instar were as follows: I, 50–90 per cent; II, 50 per cent; III, 50 per cent; IV, 33 per cent. Adults also show signs of paralysis immediately after feeding, but recover completely within 24 hours. Egg-laying is apparently not impaired, though no record was kept of the number of eggs laid per female. Nymphs which survive their first feed, moult, and are then again fed on the 'Gammexane' rabbit, show approximately the same death-rate as nymphs of the same stage feeding for the first time. Surviving nymphs are, therefore, not resistant to subsequent feeds, and a colony of bedbugs would have little chance of surviving many generations if they feed continuously on a 'Gammexane' animal.

Aedes ægypti. Feed fully and show signs of paralysis, for example, inability to rise from the bottom of the cage, within one hour. All fully fed females died within 24 hours. Females which did not feed and males confined in the same cage were unaffected.

Ornithodorus moubata. Attach immediately but do not feed fully (adults take only an average of 9 mgm. of blood), after which they immediately detach themselves and show obvious signs of distress. Incoordination of movement and inability to walk in a straight line away from light are the most obvious signs. These signs persist for days; some ticks appear to die, others linger on with progressing signs of toxæmia. To date, ten days later, no recoveries have been noted.

Kirkwood and Phillips, working with *Saccharomyces cerevisiæ*, have shown that *i*-inositol inhibits the effect of 'Gammexane'. It is of interest to note that an intravenous injection of 10 c.c. of a 5 per cent solution of *i*-inositol into a rabbit after it had had a total dose of 250 mgm. of 'Gammexane' did not reduce the toxicity of its blood for *O. moubata* fed a few minutes after the injection.

The toxicity of 'Gammexane', when fed to animals continuously, is, so far as I am aware, not known. This will have to be determined. The fact is established, however, that it is possible to interfere with the economy of blood-sucking arthropods by feeding insecticides to the host. The use of such a method in the veterinary sphere appears to have great possibilities.

I gratefully acknowledge the technical assistance of Misses F. Hardy, U. B. Arvidsonn and Messrs. W. Ray and J. M. Thorp.

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Physiological Isolating Mechanisms and Selection within the Species *Gasterosteus aculeatus* L.

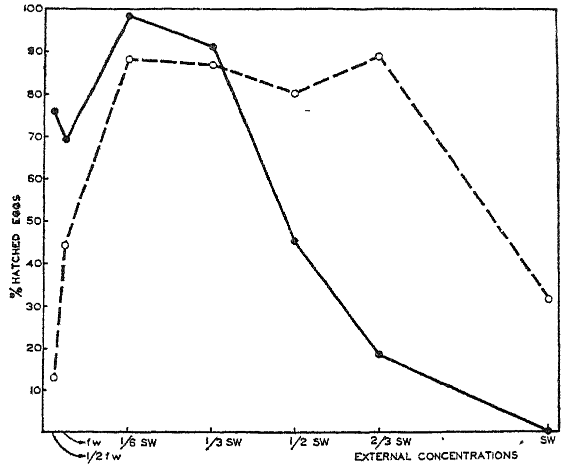
PREVIOUS work on the osmo-regulatory properties in relation to the migration of the stickleback[1] attracted our attention to physiological differences between 'forms' of this species, morphologically distinct, which Bertin[2] believed to represent modifications of a single genetic type.

Further investigations[3] provided physiological causes for the characteristic geographical distribution of these forms. The extension of the study of the osmo-regulatory properties of adult specimens, morphologically distinct as regards their number of lateral shields, at different temperatures proved the existence of physiological barriers between adult populations.

In order to investigate whether these physiological characters are in fact genetic, we undertook a breeding experiment which involved the rearing of approximately 30,000 eggs from ninety pairs of sticklebacks. The parents came from two populations, one of the form *gymnura* with a low mean plate-number, the other of *semiarmata* and *trachura* forms, with a high mean plate-number. The artificially fertilized eggs were allowed to develop at a constant temperature of 23° C. and at different salinities. The different salinities were produced from artificial sea water or ordinary fresh water, dilutions being made with glass-distilled water. The accompanying graph shows the differences in hatching percentages of the eggs.

At high and low salinities, the differences are especially sharp. Other experiments show that these differences are increased at lower temperatures. It seems probable, therefore, that under natural conditions of temperature the two populations differ sharply in their reproductive adjustment to the salinity of the habitat.

Death-rates at given salinities are not at random, but selective. This is shown by the correlations be-



———●———, eggs from *gymnura* forms;
— —○— —, „ „ *trachura* „

tween the number of plates and vertebræ of the parents, the percentage of viable embryos produced and their morphological characters when reared.

The geographical variation of the species as regards the number of lateral shields is also caused by an underlying genetic pattern, as will be shown by detailed publication elsewhere.

The evidence indicates that the mechanisms thus far detected, namely, the physiological differences between adults, the inherited physiological differences between their eggs, and the selective action of external factors, are powerful barriers to the diffusion of genes throughout the species, and maintain the variation at the evolutionary level actually reached.

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Mechanism of Crossing-over

A NUMBER of theories have emerged from time to time attempting to visualize the exact mechanism involved during crossing-over, which is now known to be the sole agent conditioning the formation of the cytologically visible chiasma. Among these the one proposed by Darlington[1] based on torsions is the most elaborate, in the sense that it offers an explanation for the long and intricate succession of events. His hypothesis, however, implies a few assumptions for which there are formidable physical objections. The most important of these are: (1) the existence of a pairing force which brings homologues together in the zygotene of meiosis, and (2) the postulate that a break at a particular level in one chromatid under strain induces a break in a non-identical chromatid at precisely the same spot due to transfer of stress. In regard to (1), every cytologist is aware of the physical difficulties which are inherent in suggesting the existence of specific attractions operating over anything more than extramolecular ranges. However, Delbrück's[2] theory of autocatalytic synthesis of polypeptides appears to provide a physico-chemical basis for this force of attraction. In order to test the validity of the second assumption, an attempt is now made to examine the forces operating in a helical system which is in equilibrium under torsion.

In a two-strand rope which is held in the form of a helix, the axial force which will keep it in equilibrium in this form is

$$F = \frac{1}{lr^2}\left[(C \cos^2\alpha + B \sin^2\alpha)\ \eta + (C - B) \sin\alpha \cos\alpha .\ \theta\right],$$

where l is length of rope; r, α are the radius and angle of helix; η is axial displacement; θ is angular displacement at end of rope; C, B are constants. The tension at any point of the rope is constant and is $J = F \sin \alpha$. η and θ are proportional to l, so that at any intermediate point Q of the rope, distant l_1 from the fixed end, their values are

$$\eta_1 = \frac{l_1}{l}\ \eta,\ \theta = \frac{l_1}{l}\ \theta.$$

Hence we may also write

$$F = \frac{1}{l_1 r^2}\left[(C \cos^2\alpha + B \sin^2\alpha)\ \eta_1 + (C - B) \sin\alpha \cos\alpha .\ \theta_1\right].$$

Suppose now the string is in equilibrium under the action of F applied at its end. If one of the strands is cut at Q, the torsional couple at that point is annulled and the two ends will revolve in opposite directions. But it is an essential feature of the theory that this release of torsional strain is confined to a narrow region near the cut. This is based on the assumption of an affinity or lateral cohesion between the two strands. Hence we may suppose that the effect of the cut is to make the loose ends revolve through small angles. Since the torsional equilibrium of the rope is due mainly to the co-existence of torsional couples in both the strands, it follows that the local release of twist in one strand will result in a corresponding release of twist in the other also at the same point. This will result in changing η_1 and θ_1 at that point in the uncut strand to new values η_1' and θ_1', which will be less than the original values η_1 and θ_1. The corresponding equilibrium value of F, namely, F', is given by

$$F' = \frac{1}{l_1 r^2}\left[(C \cos^2\alpha + B \sin^2\alpha)\ \eta_1' + (C - B) \sin\alpha \cos\alpha .\ \theta_1'\right],$$

so that

$$F' < F.$$

If we suppose that the rope was in limiting equilibrium under F, then it is clear that after one of the strands is cut, it is under the action of F which is more than the value F' required for equilibrium. Hence there is a high probability that the uncut strand will also break at the same point, since the tension at that section is greater than the value required for equilibrium.

Thanks are due to Mr. V. R. T. Achar and to Dr. B. R. Seshachar for helpful criticism.

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MEDAL AWARDS OF THE ROYAL SOCIETY*

Copley Medal

THE Copley Medal is awarded to Prof. Edgar Douglas Adrian, professor of physiology in the University of Cambridge, for his outstanding contributions to nerve physiology.

During the last thirty years, Prof. Adrian has been engaged on a series of systematic investigations of the essential functions of the nervous system which have been extended from a study of the activity of single nerve fibres to the reaction of the cortex of the forebrain of man to impulses that reach it from the periphery. The advance of our knowledge of the working of the nervous system is largely the result of his researches into the nature of the fundamental process of individual cells and combinations of cells.

His early work with Keith Lucas provided important observations on conduction by nerve fibres and on the reactions of muscles. This was followed by a series of independent researches by the combination of a valve amplifier with a capillary electrometer which made possible an analysis of the behaviour of individual sensory receptors and of single motor units. Among many important discoveries these investigations revealed how the frequency of impulses conveyed by each fibre is used in the central nervous system to signal the intensity of peripheral and central events. By the same methods, he undertook a detailed analysis of the activity of many types of sense organs and of simpler reflex actions in terms of the activity of single nerve fibres, and in some cases demonstrated that the same principles underlie all nervous activity throughout the animal kingdom. Other investigations dealt with the nature of the fundamental process in nerve cells and in synaptic regions of the central nervous system.

During the past ten years Prof. Adrian has been mainly concerned with the interpretation of the potential waves in the cortex of the forebrain. Hans Berger had directed attention to the existence of these in man, but the subject was neglected until Adrian and Matthews reinvestigated it. Adrian's subsequent studies included, in the first place, an examination of the electrical activity of the brain and its reaction to messages from the periphery, and in the second place a mapping out of the regions of the cortex which serve as receiving centres for such messages. His aim has been to analyse these phenomena in terms of activity of simple nervous units, and the results of his work are the basis of the subsequent development of electroencephalography, which has attained an important place in both physiological and clinical investigations.

By his researches on the exposed brains of animals, Prof. Adrian determined the laws of spread of activity in the cortex, its reactions to natural and artificial stimuli that reach it, and showed that the interaction between a local excitation and the background of spontaneous activity is the essential feature of a cortical response. By a study of the comparative physiology of the sensory areas of the brain he has also shown how their development and to some extent their reactions to peripheral stimuli depend on the structure and mode of life of the animal.

After determining the representation in the brain of receiving stations for superficial and proprioceptive stimuli he investigated that of vision and hearing. He has even succeeded in demonstrating the different features of impulses that reach the visual cortex from the rods and cones of the retina; he has also dealt with the distribution and significance of certain non-sensory afferent impulses, as those that reach the cerebellum.

Adrian has blazed many trails in his exploration of the territory of nerve physiology. It is certain that for many years to come his lead will be followed and the new knowledge will be consolidated along the lines of his pioneering work.

Rumford Medal

The Rumford Medal is awarded to Sir Alfred Charles Glyn Egerton, professor of chemical engineering, University of London, at the Imperial College of Science and Technology, for his distinguished researches on combustion.

The Rumford Medal, founded in 1800, is awarded once every second year "to the author of the most important discovery or useful improvement which shall be made and published by printing or in any way made known to the public in any part of Europe during the preceding two years on Heat or on Light, the preference always being given to such discoveries as, in the opinion of the President and Council of the Royal Society, tend most to promote the good of mankind".

Sir Alfred Egerton admirably fulfils the requirements of these terms of award. He is a physical chemist whose researches have always been directed towards the application of physico-chemical principles to the process of combustion of hydrocarbons in all its ramifications. For some time the approach to combustion problems has been empirical because there was no satisfactory physico-chemical basis of the theoretical or practical aspects to make further significant progress possible. This background has now been partly provided by Egerton, who was one of the first to see clearly how necessary it was to apply the new conceptions of combustion to the complex processes occurring under the conditions obtaining in internal combustion engines. One of the great obstacles to achieving greater efficiency is the difficulty of preventing premature detonation. This phenomenon is essentially a chemical one in the sense that organic peroxides, produced during combustion, are known to be responsible for the pre-ignition. Thus the chemical behaviour of peroxides might provide a key to the solution of the problem, and much of Egerton's work has been devoted to this inquiry. The investigation involved the elaboration of special physical techniques, since ordinary chemical methods were inapplicable to this type of research.

During the War, Egerton has directed his attention to the vital problem of ensuring that combustion appliances should be devised and operated with the maximum possible efficiency. This can only be achieved by a thorough scientific analysis, hitherto lacking, mainly because the problem had scarcely been considered worthy of serious study. The result of his labours cannot fail to be of great benefit to Great Britain during the period of very low fuel production, and will lead to considerable economies in all circumstances.

The characteristic of Egerton's work has been the application of modern physico-chemical methods to current scientific and technical problems of great

* From the remarks made by the President of the Royal Society in presenting the medals for 1946.

moment, combined with experimental researches developed with great ingenuity.

Royal Medals

A Royal Medal is awarded to Sir William Lawrence Bragg, Cavendish professor of experimental physics in the University of Cambridge, for his investigations of the structure of solids.

The diffraction of X-rays by crystals was observed in 1912 by Laue, Friedrich and Knipping, but the pioneers of the present-day development are the late Sir William Bragg and his son Sir Lawrence. It was W. L. Bragg who formulated the law $n=2d/\sin\,\theta$ that is now so familiar in all studies concerned with the structure of molecules and their states of aggregation. Soon after Laue's discovery there followed, from father and son, a series of papers on the phenomena of X-ray 'reflexion' on one hand and the determination of fundamental crystal structures on the other, the far-reaching consequences of which could scarcely have been foreseen, even by their authors. At the present time, crystal analysis by X-rays is an established technique, a sharp tool of research that lays bare the complexities of organic and mineral matter alike.

The inspiration and genius of Bragg are seen in so many of the modern developments of X-ray diffraction to structural analysis that it is possible to select only a few outstanding illustrations. His principal interest has always lain in the interpretation of diffraction phenomena, with the view of making the actual methods of analysis more precise, more simple, and more extended. In developing such methods he and his collaborators have elucidated the atomic arrangement in a great number of fundamental types of inorganic crystal structures. Chief among these are those of the diamond and the elementary salts and oxides, in the study of which the subject found its first beginnings. After these, perhaps his greatest analytical success is shown in the field of the silicates. A chemical riddle has been transformed into a system of simple and elegant architecture. He has also contributed greatly to our knowledge of the structure of metals and alloys and their phase changes, and of the relations between their physical properties and atomic arrangement in the crystalline state. Latterly, he has brought to a still clearer focus the concept of X-ray diffraction as a branch of optics, and has thus initiated methods that have already gone far towards replacing the earlier laborious calculations by rapid devices based on the analogy of the diffraction of visible light.

The implications and applications of the principles and methods of X-ray spectroscopy and X-ray structure analysis are one of the wonders of modern science, and with this manifold triumph the name of Sir Lawrence Bragg is inseparably associated.

A Royal Medal is awarded to Dr. Cyril Dean Darlington, director of the John Innes Horticultural Institution, in recognition of his distinguished contributions to cytology.

The importance of Darlington's work lies not so much in the discovery of isolated new phenomena—although he has discovered many of these—but rather in the achievement of a synthesis which brings together a highly diversified body of apparently disconnected facts into an integrated system.

Darlington's first major achievement was the clarification of the relations between the two main forms of nuclear division—mitosis and meiosis. Out of the confused mass of available observations, he singled out as fundamentally significant two facts: first, that chromonemata attract one another specifically, by an attraction which is satisfied when two similar threads are associated; and secondly, that in the earliest stage of mitosis each chromosome is already split into two halves, while at the beginning of meiosis they are still single. On the basis of these two facts, he showed that the relation between the two forms of division could be understood as the result of a temporal shift in the operation of a single physiological process. His so-called 'precocity' theory of meiosis was then supported by a whole series of new observations, in which the resources of comparative study and of new techniques were used for the specific purpose of obtaining answers to critically formulated questions.

Starting from the basis of the relation between the two major forms of nuclear division, Darlington has pursued his inquiry in two directions. On one hand, he has accumulated a very large body of facts concerning the detailed mechanics of cell division in many different groups of plants and animals. The comparative method enabled him to reach important new conclusions as to the mechanism of crossing-over, the cycles of spiralization and contraction of chromosomes, the nature of the mitotic spindle and the forces exerted by it and within it, the role of the centromeres and so on. These results have laid a broad foundation of observation and deduction which appears, for the first time, firm enough to bear a superstructure of physico-chemical interpretation. Proceeding in quite another direction, Darlington discussed the implication of his cytological ideas on evolutionary theory. The existence of the mitotic and meiotic modes of division had been explained as the result of different modalities in the application of a single set of physiological principles; Darlington showed that, further, slighter modifications could produce many of the widely diverse series of reproductive mechanisms met with in the animal and plant kingdoms. He emphasized the fact that the mechanism of evolution is itself subject to evolutionary changes.

More recently, Darlington's work has led him to the investigation of the general problems of gene action, of the physiological action of the two major types of nucleic acid, and the relation between the gene and other similar bodies in the cytoplasm. Darlington was one of the first to enter this highly speculative field, and he has contributed not only his full quota of stimulating speculation, but also a large share of the still scanty facts. It is not too much to say that Darlington's results and theories are recognized as the basis of modern nuclear cytology.

Davy Medal

The Davy Medal is awarded to Prof. Christopher Kelk Ingold, professor of chemistry in the University of London, at University College, for his outstanding researches in physico-organic chemistry.

Progress in one of the most active fields of chemical science during the present century has resulted from attempts to elucidate the detailed mechanism of organic reactions in terms of modern physical concepts. Throughout this development, Ingold's contributions have been especially distinguished. Possessing detailed knowledge and understanding of both the physical and organic branches of the science, he has been in a position to effect the synthesis of the two modes of approach without which a successful attack on the difficult, yet fundamental, problems involved could not be achieved.

It is not possible in short compass even to outline the range of investigations with which Ingold has been concerned, but brief mention may be made of the work on stereochemistry dealing with ring strain and the effect of *gem* dimethyl groups on the valency angles of carbon. A further application of underlying physical principles is evident in his investigations of tautomerism in triad systems, and in the development of our ideas on ring-chain tautomerism. This work led on to more general studies of the mechanism of reactions, including the difficult question of substitution in the benzene ring, in addition to the ordinary reactions of organic chemistry, such as hydrolysis and substitution, which despite their apparent simplicity have proved to be complicated and difficult to interpret. The success which Ingold has achieved in interpreting these phenomena in terms of the electron theory of valency is striking; but in addition he has played the most prominent part in the experimental investigations which have led to our present knowledge of the kinetics and mechanism of organic chemical reactions. Ingold always has been interested in the elucidation of the course of chemical change by application of physico-chemical methods based on reaction velocities, and in this field may be cited the extensive work on the mechanism of substitution at an aliphatic carbon atom, leading to the recognition of the uni- and bi-molecular processes, by means of which so much has been done to solve the difficult problems raised by the Walden inversion and the phenomena of racemization. In these intractable regions the contribution of Ingold and his flourishing school are of fundamental importance.

Another aspect of his work involves a still deeper concern with physical principles as applied to organic chemical problems. His interest in the chemistry of benzene has led him to investigate in the fullest detail, using infra-red and Raman spectra, and indeed all available physical methods of approach, the fine structure of the benzene molecule. In order to provide the necessary data it was necessary to devise methods for the preparation of the various deuterium-substituted benzenes—no mean feat of organic chemistry in itself—and the interpretation of the experimental results in terms of quantum mechanical principles has recently been published in an issue of the *Journal of the Chemical Society*, which he monopolized. Although his theoretical contributions have attracted more attention, the originality of his experimental technique is equally noteworthy and his happy selection of crucial tests amounts to genius.

Darwin Medal

The Darwin Medal is awarded to Sir D'Arcy Wentworth Thompson, professor of natural history in the University of St. Andrews, in recognition of his distinction as a zoologist.

Sir D'Arcy Thompson is now in his sixty-second year as a professor of biology and natural history. He published his first scientific paper in 1879. His most distinguished work, "On Growth and Form", appeared in 1917 and was republished in a new and enlarged edition in 1942. He is still writing, but mainly in the field of the classics, where he is a considerable scholar, and a great authority on all animals that have appeared in classical texts.

D'Arcy Thompson's scientific work ranges over a wide field of general zoology and marine biology. He is an expert on the subject of fisheries, and for a considerable period did tireless work both for the Conseil International pour l'Exploration de la Mer and the Fishery Board for Scotland, carrying out hydrographical observations and being responsible for a great deal of fishery statistics. In the main, however, D'Arcy Thompson's scientific reputation rests on his work on growth, and the dimensional relationships of animal forms. The better part of the foundation of modern research into these subjects is his demonstration of methods by which the shape of the living organism can be brought into the field of controlled mathematical inquiry.

D'Arcy Thompson's work springs essentially from an inquiry into the relationships of animal forms, and from an attempt to introduce a degree of mathematical precision into the otherwise purely descriptive language of systematic evolution. He was able to show, for example, that the evolution of one form from another could often be illuminated by the use of Cartesian transformations. By making clear the formal unity and coherence in the relationship of animals which apparently differ in a multitude of ways, his studies made possible the quantitative demonstration of steps in the evolution of different forms, and more so, the orderly process of change in the development of the same form. In his own words, growth can be studied as a systematic deformation of form at an earlier stage. He showed, for example, that relative growth-rates in different parts of the body are distributed according to an ordered system of growth-gradients. This concept can be applied to certain types of evolutionary transformation, since it helps to explain how a single genetic change can automatically affect both the size and the growth interrelations of several organs. The development and illustration of the theory of allometry is another extension of D'Arcy Thompson's ideas.

The wide variety of problems to the solution of which D'Arcy Thompson has opened the door is well indicated in the 'Festschrift' presented to him last year. In introducing his classic "On Growth and Form", D'Arcy Thompson declared that it required no preface, since it was all preface. His elaboration of the subject covers so wide a field, however, that, until such time as some different and all-embracing set of general propositions is put forward to take the place of those he propounded, individual contributions to the study of growth and bodily transformation must necessarily represent isolated developments of the structure which he has presented to us. D'Arcy Thompson's work will always be regarded as a necessary step in the development of biological knowledge.

Sylvester Medal

The Sylvester Medal is awarded to Prof. George Neville Watson, professor of pure mathematics in the University of Birmingham, in recognition of his distinguished contributions to mathematical analysis.

Prof. Watson is a mathematician of outstanding perseverance and analytical skill. For forty years he has devoted his energies to pure mathematics, and has made many important and exhaustive contributions, particularly in the field of analysis. The most important researches of Watson's earlier period are those on asymptotic expansions: his great memoir "A Theory of Asymptotic Series" appeared in the *Philosophical Transactions* of 1911 and was followed by a stream of other writings dealing with the characteristics and transformations of these series, and with their applications to several well-known functions of importance in mathematical physics. This group of discoveries has enriched the region of mathematics in which Stirling was the pioneer two centuries ago, and where the methods of approximation are reduced to a precise science. These include the method of 'steepest descent', and any account of asymptotic series to-day must be based to a great extent upon Watson's discoveries.

About that time many of the ablest pure mathematicians were trying to sum a difficult oscillating series involving Bessel and Legendre functions, which had presented itself in the theory of the diffraction of wireless waves round the earth. Watson solved the problem by a new method (1918), and went on to study the more difficult case of the transmission of electric waves when it was assumed that the earth is surrounded by a concentric conducting layer, as suggested by Heaviside. Watson's powerful analysis made possible a great advance in the physical theory.

Another example of his capacity for providing a brilliant solution of a problem which had been attempted by many of his predecessors is furnished by his paper on the Rogers–Ramanujan identities. Following this came his work on general transforms in which he solved a problem which many celebrated mathematicians had attempted without success. This is probably Watson's greatest achievement, and ranks as one of the most important contributions to the subject made in recent years. In addition it has had the great merit of inspiring a large amount of work by other mathematicians. Among the more notable papers of the next years were those on "Generating Functions of Class-Numbers", on Ramanujan's continued fraction, and one that gave the proof of Ramanujan's assertion about the number 691 which occurs in 'almost all' the terms of a certain infinite product when expressed as a series. The series of papers on singular moduli, during the period 1932–36, are deservedly celebrated.

His great book on Bessel functions is perhaps the most impressive single work that has ever been written on the analysis of functions. In collaborating with Prof. E. T. Whittaker in the second and later editions of "Modern Analysis", he has shown the same breadth and power and has influenced the course of higher analytical mathematical teaching throughout the world.

Hughes Medal

The Hughes Medal is awarded to Prof. John Turton Randall, Wheatstone professor of physics at King's College, University of London, in recognition of his distinguished contributions to applied physics, and especially of his development of the magnetron.

In 1940 Prof. Randall, while working in the laboratory of Prof. M. L. Oliphant, at Birmingham, agreed to join Dr. H. A. H. Boot in an endeavour to utilize the magnetron principle for the production of electromagnetic waves of frequency greater than 3,000 Mc./sec. Previous work in the laboratory had shown that satisfactory circuits for these wave-lengths must be an integral part of the internal structure of the valve itself. Randall and Boot together put forward the suggestions that such a circuit, for a multi-segment magnetron, should consist of a revolver-like arrangement of holes, spaced evenly about a circle, each hole communicating by means of a slot with a central cavity in which the cathode was mounted. The first trials with demountable valves using tungsten cathodes were immediately successful, and it was shown that the suggested form of valve can generate continuously oscillations of the required wave-length.

With the assistance of S. M. Duke, Randall and Boot were able to develop methods of construction of the magnetron which enabled oxide-coated cathodes to be used, and which therefore gave high powers when the valve was subjected to pulsed operation. Empirical investigation fixed the best coupling arrangement by which the power could be fed into an external circuit. Careful investigation of the operation of a valve showed that it was subject to sudden changes of wave-length, a condition which limited its applicability to Service equipment. This difficulty was overcome by the 'strapping' methods developed by Dr. J. Sayers.

There is little doubt that the magnetron valve was the prime factor in the improvements made in radar during the War, and Randall deserves a very large share of the credit for this development.

He contributed also to the problem of crystal detection of centimetre waves.

Randall's studies of fluorescence and phosphorescence were of a high standard, and his careful and painstaking experimental work did much to establish on a firm basis the theories of semi-conductors developed by Wilson and others, and especially the assumptions about the existence of 'electron traps'. His work on practicable phosphors has been of importance in the development of fluorescent lamps, and of the screens of cathode-ray tubes.

Randall has also made contributions to the X-ray investigation of the structures of glasses and of liquids, and he developed satisfactory forms of oxide cathodes for the fluorescent lamps.

ELECTROMETRIC ANALYSIS

A JOINT meeting of the Physical Methods Group of the Society of Public Analysts and other Analytical Chemists, the Cardiff and District Section of the Royal Institute of Chemistry and the South Wales Section of the Society of Chemical Industry was held at University College, Cathays Park, Cardiff, on October 11, when three papers were read on "Electrometric Analysis".

In discussing the improvements to pH-measuring apparatus for use with the glass electrode, Mr. A. D. Elmsly Lauchlan pointed out that if the glass electrode is to be robust, its resistance will be very high, and accurate results can only be obtained if the valve is arranged to have a high grid resistance, such as 10^{13} ohms, and the lead from the electrode to the valve is well screened and carefully insulated; a leakage of 10^{9} ohms can produce errors of about 8–9 per cent. The use of modern insulating materials, however, has raised the insulation to such a level as to make error from this source negligible. Small four-electrode valves are now used instead of the large special electrometer types, and an instrument was shown in which these improvements have been carried out.

Some manufacturers in the United States have adopted the electronic detector, the so-called 'magic eye', in place of the usual galvanometer; but possibly on account of its slightly lower sensitivity and the difficulty in noticing small changes in the shadow at the balance point, it has not been used on pH meters in Great Britain. The expansion of automatic recording and controlling of pH has been largely due to such improvements as have been made in manually operated instruments, rather than to any particular feature of the recorder itself.

Improvements in the glass electrode due to the use of pure materials free from aluminium oxide have enabled theoretical results to be obtained over a wide range of pH. Such electrodes are thick and strong, and can be made as small as 2·5 mm. in diameter; they are useful for micro-tests and for medical and dental work.

Further improvements have resulted in the production of a glass electrode for use in the alkaline range up to pH 14; the sodium ion error of a 1 N solution at pH 12 is zero with the new electrode, whereas for the usual type it is about 0 6 pH. The accuracy of such an electrode was about 0·02 pH. Examples of various types of glass electrode were shown.

The latest types of electro-titration apparatus are much neater and smaller than the prototypes, and here again the galvanometer or the 'magic eye' is employed as the detector of the equivalence point. The slightly lower sensitivity of the 'magic eye' is of less importance, as much larger potential changes are encountered. The instruments are battery- or mains-operated, depending on the detector used, and there is little to choose between them in a matter of convenience. Both types were suitable for all the usual acid–alkali and potentiometric titrations, and a demonstration of the latter was given showing the large deflexion at the equivalence point with one drop of a dilute solution. These instruments are especially convenient for the 'dead stop' end-point method, which is rapidly finding new fields.

The applications of the electro-titration apparatus were discussed more fully by Mr. R. J. Carter, who dealt with acid–alkali, precipitation and oxidation-reduction types in general, and with the Karl Fischer method of determining small amounts of water in some detail. Electrometric methods for acid–alkali titrations are particularly suitable where feebly dissociated acids and bases give poor end-points; accurate results can nearly always be obtained by noting the change of sign of the second differential when the E.M.F. is plotted against the volume of the reagent used. Titrations can also be carried out in non-aqueous media made conducting by the addition of lithium chloride, or by using a mixed solvent such as benzene and isopropyl alcohol with 1 per cent of water. The solvent must permit sufficient ionization of acidic materials of dissociation constants greater than 10^{-7} in water.

A method for determining the saponification number of fats and oils, which avoids the need for a blank titration, was described. The titration curve obtained, after saponifying the oil, by titrating with acid shows two breaks; the acid added in the portion between the two inflexion points on the curve is the amount required to liberate the free fatty acid, and this is equivalent to the saponification number of the oil.

A series of graphs giving the types of titration curves obtained with various non-aqueous solvents was shown, indicating that by a choice of a suitable solvent it is easy to distinguish between acids the pKa (aqueous) values of which are very close together.

In many potentiometric titrations, particularly those involving the use of silver, there is a danger that the liquid from the reference cell may leak out and contaminate the test solution. This difficulty is neatly overcome by the use of the glass electrode as reference cell, provided the hydrogen ion activity of the solution does not change appreciably.

Examples were given of the titration of two ions in solution in the presence of each other, such as hydrogen sulphide and thiophenol, by titrating with $N/10$ alcoholic silver nitrate in $N/10$ alcoholic sodium acetate, a procedure comparable with the estimation of mercaptans in petroleum. Graphs were also shown of titration curves of the simultaneous determination of iodide and chloride, and of thiocyanate and chloride.

The oxidation-reduction titration by ferrous ammonium sulphate of the nitrate ion, formed by the decomposition of nitroguanidine with concentrated sulphuric acid, and its possible application to the estimation of nitrourea, were mentioned, together with the determination of fluorine in organic compounds with cerous nitrate, as interesting extensions of older methods.

Polarization end-points, discussed in principle in the third paper, were shown to have applications to already existing methods, such as the determination of dissolved oxygen in water and of ascorbic acid by means of 2 6 dichlorophenol indophenol. The method offers greater sensitivity than the starch indicator and is also capable of high accuracy in coloured solutions.

Perhaps the most outstanding use to which the method has been placed is the determination of small amounts of water by means of the Karl Fischer reagent, used for the determination of moistures. The material of which the water content is to be determined is mixed with a solution of iodine in pyridine saturated with sulphur dioxide; the water in the sample allows some of the iodine and sulphur dioxide to react, and the excess iodine is found by back titration with methanol containing a known quantity of water. The complete removal of the iodine at the end-point allows the cathode to become polarized and the galvanometer needle returns to zero. By the use of a higher polarizing E.M.F. of 1–2 volts instead of the more usual 15–20 millivolts, it has been found possible to make a direct titration, when the end-point is given by the excess iodine depolarizing the cathode and causing the galvanometer needle to be deflected.

From the amount of literature on the subject, the method appears to have almost unlimited applications, such as the estimation of organic radicals, carbonyl compounds by reaction with hydroxylamine hydrochloride, the hydration of salts, and the analysis of mixtures of primary and secondary amines.

It was a pity that Dr. D. P. Evans's paper on polarization end-points could not be given in full, owing to the lateness of the hour, as this subject is well worth careful study by those interested in improving existing titrations and also in finding new volumetric methods. A brief description was presented of the principle of the polarization end-point, which was first given proper recognition by Foulk and Bawden in the United States; the method is particularly attractive as the ease of determining the equivalence point is much greater than with the potentiometric methods, the attainment of equilibrium being almost instantaneous.

When two noble metal electrodes are immersed in a solution and are connected to a source of E.M.F. less than the maximum back E.M.F. developed by the system, a current will flow for a short time until small quantities of oxygen and hydrogen have been deposited on the anode and cathode. The back E.M.F. developed then reduces the current to an extremely small value, so that a galvanometer connected in series with the electrodes almost immediately shows no deflexion, or at the most only a small displacement of the needle. The subsequent addition of a substance capable of depolarizing one of the electrodes gives rise to a deflexion on the galvanometer.

In order to demonstrate the method, a titration of $N/500$ sodium thiosulphate with iodine was shown. With the electrodes immersed in the solution of thiosulphate and connected to a source of E.M.F. of 15–20 millivolts, the galvanometer showed zero deflexion since the back E.M.F. of the cell is due to the polarization of the cathode; the anode remains depolarized by the reducing action of the thiosulphate. The addition of small quantities of iodine causes a temporary displacement of the galvanometer needle as the iodine partially depolarizes the cathode; but the hydrogen, which has been removed, is quickly replaced, and the needle returns to zero until an excess of iodine keeps the cathode depolarized and reduces the back E.M.F., so that the galvanometer needle is steadily deflected by the current flowing.

An inversion of the above titration allows the current to flow until the thiosulphate removes all the iodine and allows the back E.M.F. to rise, bringing the current and therefore the galvanometer needle to zero; hence the term 'dead stop' end-point.

In practice, it is considered better to adopt the former scheme whereby the electrodes remain polarized until the equivalence point, as there is not the same danger of over-running the end-point.

When working with dilute solutions such as $N/500$, an error can arise due to an insufficiency of iodide ions to depolarize the anode, so that the accidental current passing with the addition of each drop of iodine added to the thiosulphate results in polarization of the anode and, therefore, an increase in the back E.M.F. An excess of iodine must then be added to reverse the galvanometer deflexion. This error can amount to 0·16 ml. on 1 ml. of $N/500$ iodine; but by the simple expedient of adding 5 ml. of 10 per cent potassium iodide solution, results repeatable to 0·01 ml. of $N/500$ iodine can be obtained, an accuracy far beyond the capabilities of the starch indicator.

In the discussion which followed these papers, the relative merits of the galvanometer and the 'magic eye' as the detector in *p*H meters were reviewed; it was stated that while it was possible to detect changes of 2–3 millivolts on the 'magic eye', the galvanometer was considered to be rather better as changes of 1 millivolt could be noted. The mention of standard half-cells for electro-titrations brought forward the interesting application of the glass electrode for such a purpose where changes in *p*H do not take place. When such a condition could not always be obtained, it was possible to have a glass electrode made specially insensitive to *p*H changes.

After hearing the papers, it was clear that electrometric analysis should not and need not be considered as a special means to be used when others fail; suitable apparatus and well-tested methods are now available, which together can help the analyst to obtain more quickly even more accurate results. The papers presented at the meeting will be published in due course in the *Analyst*.

A. D. ELMSLY LAUCHLAN

VENEREAL DISEASES IN GREAT BRITAIN

RELIABLE information about the incidence of venereal diseases in Britain is still lacking. This is particularly the case with gonorrhœa, where many patients, especially since the sulphonamide era, seek private treatment. Since 1931, when clinics began to record numbers of 'new' syphilis infections (of less than one year's duration), it has been possible to get a fairly accurate idea of the trend in this disease.

The increase in syphilis in the First World War was offset in the two decades that followed by the use of drugs of the arsphenamine series. For gonorrhœa there were, until comparatively recently, no comparable remedies, and the figures for this disease remained unchanged between the Wars.

The Second World War brought a marked increase in venereal diseases, but the use of sulphonamides for gonorrhœa, and, more recently, of penicillin for both gonorrhœa and syphilis, has kept the situation from degenerating to the state reached in 1918.

The incidence of early syphilis contracted in Britain declined by more than 46 per cent between 1931 and 1939, rose sharply then to reach a peak about 1943 and then started to decline slowly. An increase in 1945 suggests the importation of disease from abroad. The rate per 10,000 of population was: in 1931, 2·28; 1939, 1·21; 1943, 2·34; 1944, 2·26; 1945, 2·60.

So far as can be ascertained the increase in gonorrhœa was less than that in syphilis, and reached its peak in 1942, when it was probably about 86 per cent higher than in 1939. By 1944 it had declined to about 35 per cent higher than in 1939, but this decline was entirely accounted for by males, the rate in females actually increasing in 1944.

In 1942 the Government, in co-operation with the Central Council for Health Education, began a campaign to combat the spread of venereal diseases. Radio broadcasts, films, newspaper and magazine advertisements, posters and pictorial exhibitions were employed. Surveys suggested that the campaign was approved and understood by the public.

The introduction of Defence Regulation 33B in 1942 was the first departure from the practice of treating venereal disease on an entirely voluntary basis. The Regulation was aimed at the habitual spreader of disease and provides that any person named as a source of infection by two or more patients may be compelled to undergo examination by a special practitioner and to receive any necessary treatment until pronounced "free from venereal disease in a communicable form". Only a few thousands of cases have been thus brought under control, but even so the effort has been of importance.

There has also been increasing use of social workers by treatment centres to trace contacts and do follow-up work.

Since 1939, forty-one new treatment centres have been opened, and existing centres have held additional sessions. There was close co-operation between the civilian and the Forces venereal diseases services[1].

Specially qualified general practitioners have been appointed, especially in rural areas, to treat patients with venereal diseases, and the increased facilities ensure, so far as possible, that no patient need travel more than ten miles for treatment.

JAMES MARSHALL

[1] *Nature*, 151, 46 (1943).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 9

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at Faraday Building, 9th Floor, South Block, Knightrider Street, London, E C.4), at 5 p m.—Mr C. H. Wright "The Circuit Laboratory in War-time".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C.2), at 5 p m —Capt J C Taylor · "Marine Life-Saving Appliances" (Thomas Gray Lecture)

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W.1), at 6 p.m —Major Kenneth Gordon "Progress in the Hydrogenation of Coal and Tar".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7 15 p m —Mr. J. O. C. Vick. "Organisation of an Industrial Instrument Department".

CHEMICAL SOCIETY, EIRE SECTION (in the Department of Chemistry, University College, Upper Merrion Street, Dublin), at 7 30 p m.—Prof. Harold C. Urey. "Isotopes".

Tuesday, December 10

BRITISH RHEOLOGISTS' CLUB (joint meeting with the FARADAY SOCIETY, at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 2.30 p m —Mr R L. Brown. "Dilatancy" Dr. E. W. J. Mardles "Thixotropy"

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 5 p m —Scientific Papers

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p m.—Sir Harold Spencer Jones, F R S. "Three Astronomical Centenaries, 3, The Discovery of the Planet Neptune, 1846".*

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W C.2), at 5.30 p m —Discussion on "The Design and Performance of Receiving Aerials for Television" (to be opened by Mr E. C Cook, and to which members of the Television Society are invited)

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W C.1), at 5 30 p.m.—Dr. Tracy Philipps: "The European Ethnological Composition of Canada"

ILLUMINATING ENGINEERING SOCIETY (at the E.L M A. Lighting Service Bureau, 2 Savoy Hill, Strand, London, W C 2), at 6 p m.—Mr. A. Cunnington and Mr. G. W. Golds "Railway Lighting, some Lessons from Experience and Views on the Future".

CHEMICAL SOCIETY, NORTHERN IRELAND BRANCH (in the Great Hall, Queen's University, Belfast), at 8 p m.—Prof. Harold C. Urey: "Isotopes".

INSTITUTE OF PHYSICS, SCOTTISH BRANCH (at the University, Glasgow),—Prof M L Oliphant, F.R S . "Betatrons".

INSTITUTION OF STRUCTURAL ENGINEERS, LANCASHIRE AND CHESHIRE BRANCH (at the College of Technology, Manchester) —Mr. F. R. S Smith and Mr. G. Forrest. "Aluminium Alloys, their Properties and some of their Applications to Structure".

Wednesday, December 11

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5 p m.—Dr W. Hubball "The Cotton Trade's War-time Commodity Supplies".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C 2), at 5 p m —Mr John Gloag. "Planning Research for Industrial Design".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 30 p.m —Dr. Basil Charles King. "The Textural Features of the Granites and Invaded Rocks of the Singo Batholith of Uganda and their Petrogenetic Significance"; Mr. Peter Colley Sylvester-Bradley: "The Shell Structure and Evolution of the Mesozoic Ostracod *Cypridea*".

INSTITUTE OF PETROLEUM (joint meeting with the INSTITUTION OF FIRE ENGINEERS, at Manson House, 26 Portland Place, London, W.1), at 5.30 p m.—Symposium on "Oil Fires".

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p m —Mr. R C. Cuffe: "Lightning Surges on Transmission Lines in Ireland".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5 30 p m.—Mr. F Ian G. Rawlins: "Natural Philosophy and the Fine Arts" *

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p m —Mr. S P. Woodley: "Photolofting".

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p m —Films "Steam" (Babcock and Wilcox); "Steam" and "Furnace Practice" (Ministry of Fuel and Power).

INSTITUTION OF CIVIL ENGINEERS, NORTH-WESTERN ASSOCIATION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. M. Wishart: "The Development of Sewage Purification Processes".

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE-UPON-TYNE SECTION (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. R. Belcher and Dr. C L. Wilson · "Methods and Apparatus in Inorganic Microchemistry", including a demonstration of methods and an exhibition of apparatus.

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. D. P. Hopkins: "Fertilizers, Manures and Nutrition" Members of the Agriculture and Food Groups are invited).

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (at the Loughborough Hotel, Loughborough), at 7 p m.—Symposium on "U S A. and Canada".

Thursday, December 12

SOCIETY OF DAIRY TECHNOLOGY, MIDLAND SECTION (at the North Stafford Hotel, Stoke-on-Trent), at 2 p m —Mr. H. B. Hawley "Aspects of Creamery Hygiene and Process Control"

IMPERIAL INSTITUTE, MINERAL RESOURCES DEPARTMENT (in the Cinema Hall, Imperial Institute, South Kensington, London, S.W.7), at 3 p m.—Mr. L J. D Fernando · "The Geology and Mineral Resources of Ceylon" (Recent Progress in Geological Investigation and Mineral Developments in the Colonies, 6).*

INSTITUTE OF FUEL, EAST MIDLAND SECTION (at the Gas Demonstration Theatre, Nottingham), at 3 p m.—Dr C C Hall "Oil from Coal by the Fischer - Tropsch Process in Germany".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 5 p.m —Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p m.—Dr Kathleen Lonsdale, F R S . "What Chemistry Owes to X-Rays, 2, Organic and Biological Chemistry".*

INSTITUTION OF ELECTRICAL ENGINEERS, INSTALLATIONS SECTION (at Savoy Place, Victoria Embankment, London, W.C 2), at 5 30 p m —Dr. G E Haefely: "Growing Importance of Plastics in the Electrical Industry".

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 6 p.m —Mr Kenneth Gordon. "Progress in the Hydrogenation of Coal and Tar"

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (joint meeting with the ILLUMINATING ENGINEERING SOCIETY, in the Reynolds Hall, College of Technology, Manchester), at 6.30 p m —Dr. J. H Shaxby · "Colour and the Eye"

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St James's Park, London, S W 1), at 6 30 p.m —Mr Z M Rogowsky: "Mechanical Principles of the Screw Extrusion Machine"

WOMEN'S ENGINEERING SOCIETY (in Room 4, Gas Industry House, 1 Grosvenor Place, London, S W.1), at 6 30 p.m —Exhibition of Technical Films. "Engineering in War and Peace", "The Mosquito", "Kelvin, Master of Measurement".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester 2), at 6.30 p m.—Miss A. G. Shaw: "Motion Study".

CHEMICAL SOCIETY (in the Chemistry Department, The University, Manchester), at 7 p m —Scientific Papers.

ROYAL PHOTOGRAPHIC SOCIETY (joint meeting of the SCIENTIFIC AND TECHNICAL GROUP and the COLOUR GROUP, at 16 Princes' Gate, London, S.W 7), at 7 p m —Mr R G Horner · "Requirements of Reproduction" ("How it Works in Colour Photography", 2).

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W C 1), at 7 p.m.—Dr. T. E Wallis · "A Study of Pollen".

ROYAL INSTITUTE OF CHEMISTRY, TEE-SIDE SECTION (joint meeting with the NEWCASTLE SECTION of the SOCIETY OF CHEMICAL INDUSTRY, at Norton Hall, Norton, Stockton-on-Tees), at 7.15 p.m —Dr. M. P Applebey "The Changing Relation of Science and Industry".

SOCIETY OF DYERS AND COLOURISTS, WEST RIDING SECTION (at the Great Northern Victoria Hotel, Bradford), at 7 15 p.m.—Dr. C. S. Whewell "Further Developments in Scouring"

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (joint meeting with the GUILD OF PUBLIC PHARMACISTS, in the Lecture Theatre, St. Mary's Hospital, Manchester), at 7 45 p.m.—Mr. R. G. Heppell: "Radium in the Treatment of Cancer".

Friday, December 13

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr F. Fancutt and Dr. J. C Hudson: "The Protection of Ships' Bottoms, and the Formulation of Anti-Corrosive Compositions".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m —Mr. J. P. M. Prentice "Visual Observation of the Giacobinids, 1946"; Dr. A. C. B Lovell, Mr. C. J. Banwell and Mr. J. A. Clegg "Radio-echo Observation of the Giacobinids, 1946"; Mr. J S. Hey, Mr. S. J. Parsons and Mr. G. S. Stewart. "Radar Observations of the Giacobinid Meteor Shower, 1946"; Prof. S. Chapman, F.R S · "Electromagnetic Forces in Solar Prominences" (discussion), Prof. T. G. Cowling: "Alfvén's Theory of Sunspots".

CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. D. Allan. "A Survey of Fat Splitting".

INSTITUTE OF FUEL, SOUTH WALES SECTION (at the Engineers' Institute, Cardiff), at 5.30 p m.—Dr. J. H. Griffiths "Cleaning South Wales Small Coal".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p m —Mr R. S J. Spilsbury and Mr. A. Felton: "A Millisecond Chronoscope"; Mr. A. Butterworth "A Sensitive Recording Magnetometer".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5 30 p m.—Mr. S. J. Wright "Mechanical Engineering and Agriculture" (First Agriculture Lecture).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p m.—Sir Alfred Egerton, F.R.S.: "Combustion of Fuels" (Andrew Laing Lecture).

INSTITUTE OF ECONOMIC ENGINEERING, LONDON REGION (at Cowdray Hall, Henrietta Place, London, W.1), at 7 p.m.—Mr. J. R. Kell. "Industrial Heating".

PAPER MAKERS' ASSOCIATION (TECHNICAL SECTION), NORTHERN DIVISION (at the Engineers' Club, Manchester), at 7 p m —Mr Edwin Davis · "Non-Ferrous Metals in the Paper Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p m —Dr C R Harington, F.R S "The Body's Chemical Mechanisms of Defence"

Saturday, December 14

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, STUDENT SECTION (at Bolbec Hall, Newcastle-upon-Tyne 1), at 6.45 p m —Mr. Robert Hinchliffe "50 Years of Progress in Propulsive Efficiency".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

LECTURER IN BIOLOGY (with subsidiary Chemistry) at the Technical College and School of Art—The Chief Education Officer, Shire Hall, Cambridge (December 14).

TEACHER OF MECHANICAL ENGINEERING SUBJECTS in the part-time Day and Evening Classes and the Secondary Technical School of Engineering—The Principal, Hendon Technical College, The Burroughs, Hendon, London, N W 4 (December 14).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER for work on general information, preparation of reports, etc , a SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER for statistical work on problems connected with the carbonization of coal in coke ovens and general investigations, a SCIENTIFIC OFFICER or EXPERIMENTAL OFFICER for work at the Midland Coke Research Station, Sheffield, and LABORATORY ASSISTANTS, Grades II and I, for work at the Midland Coke Research Station, Sheffield, with experience in the Coke Oven Industry—The Secretary, British Coke Research Association, 11-12 Pall Mall, London, S W 1 (December 16)

SENIOR EXPERIMENTAL OFFICERS (9) at the Building Research Station of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1703 (December 19)

SENIOR PRINCIPAL SCIENTIFIC OFFICER, and PRINCIPAL SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS (2), in the Road Research Laboratory of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1, quoting No 1702 (December 19).

PRINCIPAL SCIENTIFIC OFFICERS (2), PRINCIPAL SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS (2), and SENIOR SCIENTIFIC OFFICERS (4), at the Building Research Station of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1704 (December 19)

SENIOR PRINCIPAL SCIENTIFIC OFFICER to take charge of the Physics Section of the Fuel Research Station of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No 1700 (December 19).

PHYSICAL CHEMISTS as Principal Scientific Officers in the Chemical Research Laboratory of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1701 (December 19).

PRINCIPAL LECTURERS, SENIOR LECTURERS and LECTURERS (permanent and temporary) in metallurgy, heat engines, machines, mechanics and materials, at the Military College of Science, Shrivenham, Swindon—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1698 (December 20)

PSYCHIATRIST, experienced and fully qualified (with good practical experience of the treatment of children)—The Hon. Medical Director, Belfast Child Guidance Clinic, Belfast Hospital for Sick Children, Belfast (December 20).

CHIEF METALLURGIST by the Ministry of Supply to take charge of the chemical, metallurgical and testing laboratories of the Royal Ordnance Factory, Woolwich—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting No. F.1257A (December 23).

LECTURER IN ORGANIC CHEMISTRY—The Principal, Brighton Technical College, Brighton 7 (December 28).

REGIONAL DIRECTORS of Extension Work (2)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (December 31)

CURATOR of the City Museums—The Town Clerk, Room 57, Civic Hall Leeds 1, endorsed 'Curator of the City Museums' (December 31).

SENIOR LECTURER IN EDUCATIONAL PSYCHOLOGY at the Brighton Training College for Women—The Education Officer, 54 Old Steine, Brighton (December 31).

DEVELOPMENT ENGINEER—The Deputy Director, Scottish Seaweed Research Association, West Mains Road, Edinburgh 9 (January 1)

LECTURER IN CHEMICAL ENGINEERING—The Acting Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

CHEMIST with a view to being trained for spectrographic analysis—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8.

ASSISTANT LECTURER IN PHARMACOLOGY—The Dean, Guy's Hospital Medical School, London Bridge, London, S E.1.

CHEMIST, and a TECHNICAL ASSISTANT, in the Department of Chemical Pathology—The Secretary, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1

ANALYST familiar with modern methods of organic quantitative micro-analysis—The Administrative Officer, National Institute for Medical Research, Hampstead, London, N.W.3.

CHEMISTS (3, male) in the laboratories of the Plant and Animal Products Department—The Establishment Officer, Imperial Institute, South Kensington, London, S W.7.

RESEARCH WORKERS to investigate problems concerning the relationship of footwear to health—The Director of Research, British Boot, Shoe and Allied Trades Research Association, 30-36 Thorngate Street, Kettering.

RESEARCH ASSISTANT IN ZOOLOGY—Prof A D Peacock, University College, Dundee

RESEARCH OFFICERS (a PHYSICIST, a PHYSICAL CHEMIST and a CHEMIST), an ASSISTANT RESEARCH OFFICER, and LABORATORY ASSISTANTS—The Director, British Paper and Board Industry Research Association, St Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

GRADUATE ASSISTANT IN THE MECHANICAL ENGINEERING DEPARTMENT with special qualifications in Thermodynamics—The Principal, Erith Technical College, Erith Road, Belvedere, Kent

LECTURERS IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Principal, Borough Polytechnic, Borough Road, London, S E 1

SENIOR LECTURER IN PHYSICS—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C 3

LECTURER IN MECHANICAL ENGINEERING in the Harris Institute—The Principal, Technical College, Corporation Street, Preston.

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LAND UTILIZATION AND SERVICE TRAINING IN GREAT BRITAIN

WHEN "The Threat to the Peak" was published by the Council for the Preservation of Rural England in 1931, it was the disfigurement of the landscape by incongruous and ribbon building, by highway development and to a lesser extent by electricity, water, or industrial undertakings that the Council was chiefly concerned to avert. There can be no doubt as to the value of the work of the Council in educating public opinion in this matter in the Peak district and elsewhere. While it may be true, as Dr. C. M. Trevelyan has observed, that outrages cheerfully perpetrated twenty years ago would be impossible at the present time, the threat to the natural beauty of Britain is at present much more widespread and serious to-day. Observations on landscape preservation in the Dower Report indicate the wide range of threats to some of our areas of great natural beauty, and the urgent need for legislation. Although ribbon building is officially frowned upon, dilatoriness in dealing with the planning of land use and the problem of compensation and betterment are encouraging the further extension of suburban sprawl Even the London County Council had to be restrained by the Minister of Town and Country Planning from violating the Abercrombie plan by breaking into the green belt at Chessington with a large housing estate, and the House of Lords rejected the Leicester Corporation's proposals for a reservoir in the Manifold valley.

The unilateral and unco-ordinated plans of local authorities, as in the Ennerdale proposals of the Whitehaven Corporation and the apparent intention of the Cumberland County Council to dam Mosedale, constitute a growing menace in the absence of any effective authority to implement the proposals of the Dower Report regarding national parks. Like those of the earlier reports of the Coastal Preservation Committee and of the Geological Sub-Committee of the Nature Reserves Investigation Committee, the recommendations of that Committee still await action in spite of the urgency which was attached to them even in 1942. In spite of the Chancellor of the Exchequer's allocation of fifty millions as a national land fund to enable and to encourage the acquisition by the State of land which would otherwise be sold for commercial development, the threat to our enjoyment of the hills, the moors, the woodlands, and the cliffs of which he spoke so eloquently has grown much more sinister since April.

The most serious feature of the present situation is that, in the main, it comes from the very Departments of State which might be expected to take a wide view of the public interest. The Board of Trade, for example, has also been concerned in the Ennerdale proposals, and the action of the Minister of Fuel and Power at Wentworth-Woodhouse is sadly at issue with the Chancellor's words, as well as an illustration of the absence of satisfactory arrangements for co-ordination among departments concerned with the use of land. The Standing Committee on National

Parks for England and Wales expressed last year its concern at some of the provisions of the Requisitioned Land and War Works Bill, and it now appears that there is an even graver threat in the proposals of the Service Departments to acquire fresh land for permanent training grounds.

There has already been justifiable concern in the secrecy with which the Service Departments have hitherto shrouded their plans for the disposal of land acquired in war-time for training purposes, and a request was made in the House of Lords on July 4 for a comprehensive statement showing all the areas from which it is proposed to exclude the public. That statement has never been made, and in the debate on the Address to the Throne in the House of Commons on November 15, Mr. Hollis pressed for a public inquiry in view of the new lands which it now appears the Army is proposing to acquire. Mr. Hollis asked for a statement as to the general principle of acquisition of land for Service Departments and the principle upon which the competing claims of the different Departments of State are being settled.

The Prime Minister, in reply, made a somewhat obscure statement which Mr. Hollis, with his assent, interpreted to mean that there will in future be a public inquiry whenever the Services give notice of their intention to acquire land (whether common land or not) under the Defence Act of 1842. That is reassuring so far as it goes, but it appears that the first seven cases—Dartmoor, Braunton Burrows, Ashdown Forest, Purbeck, Martindale, Castle Martin, and Harlech Morfa—are to be decided by the Cabinet after private hearings of objections before Mr. Silkin's Inter-Departmental Committee. On this question the subsequent debate in the House of Lords on November 21 was most disturbing; it did nothing to allay the anxiety aroused by the detailed statement of the Council for the Preservation of Rural England on questions arising out of the proposals for the retention by Service Departments of large areas of land for training purposes in Surrey, which are now being considered by that Inter-Departmental Committee.

These particular lands include commons long ago acquired by the War Department, to which the public has limited access, and others which of recent years have been acquired for war purposes or used under lease or licence, but which still remain in local ownership or in that of the National Trust. The main conclusion reached by the Council is that, although there is little prospect of the War Office relinquishing any of the main areas of common which it already possesses, the suggested acquisition of other commons of exceptional beauty and value to the civilian population represents a new invasion of unspoilt country which must arouse the strongest opposition. Their proximity to areas of dense population renders the Surrey commons unsuited for permanent military activity, and in view of their exceptional quality, their surface and environment should be protected.

The House of Lords debate shows how heavy is the task which falls on the individuals and private societies on whom Great Britain relies to preserve what is left of its scenic heritage, its natural playgrounds, potential nature reserves, and ancient monuments from sequestration and irreparable damage. It was never the nation's intention that the land yielded to the Services in the emergency should be theirs for evermore; and apart from the ease with which it was acquired during war-time, even when, as at Purbeck, definite pledges were given for its return, these, as Lord Cranborne pointed out, are now being evaded. Moreover, if the land was in future acquired under the Requisitioned Land and War Works Act, 1945, instead of under the Defence Act of 1842, it would be easier to bring the matter under the control of Parliament. The 1945 Act gives the right of hearing before the War Works Commission to anyone interested in the land, to voluntary societies concerned with preserving the countryside, scientific societies, or local planning authorities; if the Commission reports adversely on the Minister's proposal, he must either drop the proposal or report on it to Parliament, either House of which can pass a resolution objecting to his wish to over-ride the Commission. If such a resolution is passed the Minister's proposal lapses, and Lord Cranborne contended that this procedure is preferable; though it has been suggested that, for the time being, sufficient safeguard in the alternative procedure might be secured by a circular to lords-lieutenants directing them to consult the county council, the agricultural executive committee, the Council for the Preservation of Rural England (Scotland or Wales) and the National Trust before they give the certificate required under the 1842 Act.

Lord Cranborne spoke with justifiable force and indignation of the inclusion of Maiden Castle in a new area in Dorset scheduled by the War Office; and the growing list including the 15,000 acres at Torver, near Coniston, the Prescelly Hills in Pembrokeshire, Coquetdale, the Eppynt district of Brecon, the firing ranges on the Northumberland coast near Lindisfarne, Cader Idris, and the continued occupation of the estuary of the Taw and Torridge for amphibious operations, should suffice to warn any scientific worker interested in the proposals for nature reserves of any type of the need for concerted action. It was recognized in the report on National Parks in England and Wales that, in spite of the valuable prolegomena provided by the reports of the Nature Reserves Investigation Committee, the British Ecological Society and other bodies, we have made as yet little progress towards determining a national policy for the conservation of wild life. It would be rash indeed to attempt to force a premature decision on the proper scope and technique of protective and controlling action; but in the meantime it is imperative that men of science should join forces with other bodies in the attempt to stem the present demand for land of the Services.

One such area which has been recognized for more than a generation as of the highest importance among those requiring protection because of its scientific interest is Braunton Burrows. The value of this locality is indicated in a note in *Nature* of November

30, and it is one which last year was recommended by the Nature Reserves Investigation Committee to the Ministry of Town and Country Planning among the twenty-six sites of highest priority. It can confidently be predicted that the area will be included in any list drawn up by the Ministry's Special Committee which is now sitting. The Council of the Zoological Society has already expressed anxiety at the proposal to use this area as a training ground for combined operations, and the Wild Plant Conservation Board is also concerned that adequate precautions should be taken to safeguard the rare species of plants found there. Moreover, like many other threatened areas, Braunton Burrows is marginal land, and as has been pointed out by Mr. W. G. V. Balchin, of King's College, University of London, would rapidly suffer under intensive training conditions with destruction of the vegetative cover, disturbance or destruction of the biological balance and little chance of recovery.

Geologists will note how many of the forty-seven areas recommended as geological reserves fall within the areas at present threatened, and naturalists will equally note that while the Dower Report scheduled only four coastal areas as pre-eminently worthy of being reserved for enjoyment as national parks, claims on every one of these areas have been advanced by the War Office. Criticism of such proposals and of the way in which the projected sites for national parks are being permanently earmarked for military purposes was very vigorous in the House of Lords but was virtually ignored or brushed aside by Lord Pakenham, who admitted that the War Office had already submitted a detailed schedule of its requirements of land for training purposes comprising 225 areas. There can be little hope that the areas desirable for nature reserves will be secured for that purpose unless scientific men primarily concerned join forces with fellow citizens who, from the point of view of amenities, national parks, or other considerations are concerned to resist an outbreak of land 'grabbing' on a scale not seen since the time of the Enclosure Acts.

The time is indeed short, for the Prime Minister is understood to have requested the Inter-Departmental Committee to submit its report to him by December 15. Meanwhile, the fact that on November 27 the Secretary of State for War disclosed that the Services are at present occupying 1,100,000 acres and that they have now rights over a further 1,500,000 acres under Defence Regulation No. 52, of which 750,000 acres are at present being cleared of unexploded missiles for release, may indicate that the Government has at last seen the 'red light', and that the whole matter will be reconsidered at something approaching Cabinet level if not in public. It is the manner in which the proceedings have been taken, as much as the tracts of land themselves, which has been responsible for the general indignation, and there have been good reasons for doubting whether the Minister of Town and Country Planning, nominally in control of all land use, had anything like the standing required to uphold the public's case against pressure from the senior Service ministers.

Public protest has never been blind to the fact that it is necessary for the Services to find training areas much more considerable in scale than before the War, or that to a considerable extent such training areas may have to be found in Great Britain. Admittedly it will not be easy to find, in the limited area of Britain, tracts of land the seizure of which would not call forth angry protests. What is challenged is rather whether the demands now presented represent a reasonably economical use of land, and whether any real attempt has been or is being made to adjudicate between conflicting claims in accordance with clearly defined and generally accepted principles.

The belief that the Services are being allowed to be judges in their own cause is encouraged by the secrecy in which their claims to land are advanced. It is understood that the 225 areas mentioned by Lord Pakenham represent more than half a million acres, as against a quarter of a million held in 1938. Much of this, to judge from the areas so far disclosed, is common land, not normally suitable for cultivation, and its acquisition is unlikely to disturb food production ; but criticism in the House of Lords regarding the siting of aerodromes does not suggest that the Services are likely to show much regard for agricultural considerations. Moreover, Mr. Bellenger's statement in the House of Commons on November 27 was not the comprehensive statement demanded in July, and he did not indicate whether figures he gave represent the full demands of the Services, or whether a series of fresh demands is to be presented in a manner which makes it difficult or impossible for either Parliament or the public to judge the validity of the claims.

Other questions besides that of how much land the Services need in all are evaded. Has the possibility of using Salisbury Plain, for example, as a training ground, and moving the artillery ranges to moorland areas in the remoter parts of Scotland, been considered ? How much training of recruits and regulars could be carried out in the Dominions overseas ? What would be the extra cost of using less-convenient but adequate sites outside the national park areas ?

Such questions as these, demanding facts and figures and not the assertions with which Lord Pakenham evaded the issue in the House of Lords, might well be addressed to a Select Committee if not to a Royal Commission, and the fate of any particular area should not be sealed before informed and unbiased answers are given. It should indeed be a duty of the Minister of Defence to see that the claims on land of Service Departments are rigorously scrutinized and co-ordinated before they are presented to an inter-departmental committee at all, and that when presented they are supported not by assertions but by reasoned statement and evidence that all reasonable alternatives have been examined. "Government," wrote Burke, "is a contrivance of human wisdom to provide for human wants," and it is necessary to balance differing needs against one another when all cannot be met. But there can be no acceptable decision which does not involve the recognition by all concerned—by the Services no less than by other interests, whether scientific, agricultural or amenity—that Great Britain is a small island, and land is a precious commodity, second only to man-power in its scarcity, and demanding equally the utmost judgment and economy in its use.

It is probably still too early to assess how great and irreparable is the damage already caused to flora and fauna, apart from amenities, in those 750,000 acres which the Services are preparing to release. That some of the damage was avoidable and some even wanton is undeniable. Too much has been lost already for the danger to some of our first potential nature reserves—breeding places of rare birds, migrants and insects—involved in some of the latest proposals to be disregarded lightly, and on that ground alone scientific men should seek every opportunity of making their protest heard in company with those made on other grounds. It is, however, on the ground of spiritual values, on which the present Master of Trinity based his appeal for national parks, that the final objection must rest. If, as Dr. Trevelyan said, natural beauty stands by the side of religion, of science, of poetry and art, not as a rival but as the common inspirer and nourisher of them all, and with a secret of her own, a nation which fails fairly to take account of such values in determining its national policy will assuredly find that neither guns nor butter can repair the atrophy of the spiritual power of the people.

GALL MIDGES AND AGRICULTURE

Gall Midges of Economic Importance

By Dr. H. F. Barnes. (Agricultural and Horticultural Handbooks.) Vol. 1: Gall Midges of Root and Vegetable Crops. Pp. 104+10 plates. 12*s*. 6*d*. net. Vol. 2: Gall Midges of Fodder Crops. Pp. 160+4 plates. 15*s*. net. (London: Crosby Lockwood and Son, Ltd., 1946.)

THE gall midges or Cecidomyidæ are a family of rather primitive, structurally degenerate Diptera, of very small or minute size. They derive their name from the fact that the majority of species during their larval stages are plant-feeders which induce in their hosts the malformations termed galls or cecidia. But the family contains many more generalized species which live on fungi or in decaying plant material; and a few are carnivorous, preying upon scale insects, mites, white-flies, other gall midges and the like, letting the blood of their victims so neatly that an aphid may be bled to death without perceiving the attack.

Among the gall midges are many that attack cultivated crops, often causing serious losses. Perhaps the best known of these is the Hessian fly which, according to tradition, was introduced into America in straw bedding used by the Hessian troops during the Revolutionary War. Though not a common cause of serious trouble in Great Britain, the Hessian fly is often responsible for much damage to wheat crops in the United States and elsewhere, and attempts are being made to produce varieties of wheat that are resistant to it. In the British Isles perhaps the swede midge, the pear midge, the clover seed midge and the chrysanthemum midge are the most harmful representatives.

In spite of their biological interest and economic importance, the gall midges as a group have scarcely received from entomologists the attention they deserve—although a few of the injurious species have been intensively studied. Much of the literature about them is difficult of access, and although there are monographs describing and classifying the species of gall midges, a reference book containing the biological and economic information available about them has been lacking.

Dr. H. F. Barnes has set himself the task of writing a comprehensive account of all those species of gall midges, throughout the world, that are of economic interest either as pests of crops or as beneficial insects. He is well qualified for this task; for not only is he a taxonomist of international repute on this group of insects, but also his researches during the past twenty years have added greatly to our knowledge of their biology, their economic importance and the factors which determine the fluctuations in their numbers, the host-plant range of phytophagous species, the choice of prey among the predators—all problems of general biological interest.

The entire work will comprise an unspecified number of volumes, each complete in itself, dealing in turn with the gall midges of the various groups of crops. The first two volumes, dealing respectively with the midges of root and vegetable crops and the midges of fodder crops, clovers and grasses, have now been published. The midges are dealt with under the plants they attack, arranged alphabetically. The author is acutely aware of the pitfalls and difficulties that beset the path of the taxonomist of this group of little flies. He deprecates any attempt by the amateur to identify the species independently of their host plant and of the type of damage they produce, for "experience has shown that it is frequently more or less useless, and usually most unwise, to attempt to identify a species from keys unless biological data are available in addition". To emphasize this, the briefest possible description of each species is given, though reference to the original description is always included. Throughout the work it is the bionomics of the insect that is stressed; the information on the biology and habits of the species of economic importance should enable entomologists to identify them.

The injurious species of gall midges present particularly difficult problems to the economic entomologist, for direct methods of control are seldom practicable, and cultural methods of prevention have to be found. Detailed knowledge of its biology and life-history is a prime need in seeking means of control for any insect pest; but this applies with special force to pests that must be dealt with by cultural methods. To devise modifications in farming or gardening practice that will enable the crop to resist attack demands an intimate understanding of the relation between the insect and its plant host.

The author has brought together in a compact form all that is at present known along these lines about the gall midges that are pests in all parts of the world, and has directed attention to the many gaps that still exist in our knowledge. His books make no pretence to literary form: they are concentrated, fully documented accounts of known facts. But they are welcome both in providing entomologists with a ready means of reference to the information already acquired and as a stimulus to the further study of an important but somewhat neglected group of insects.

V. B. WIGGLESWORTH

SOIL AND CIVILIZATION

The Veld and the Future

A Book on Soil Erosion for South Africans. By Edward Roux. Pp. 60. (Cape Town: The *African Bookman*, 1946.) 5*s*.

Food or Famine

The Challenge of Erosion. By Ward Shepard. Pp xi+225+16 plates. (New York: The Macmillan Company, 1945.) 12*s*. 6*d*. net.

Reconstruction by Way of the Soil

By G. T. Wrench. Pp. 262. (London: Faber and Faber, Ltd., 1946.) 12*s*. 6*d*. net.

THESE three books bear witness to the ever-increasing awareness of the world problem of soil erosion. Ward Shepard goes so far as to claim that "modern man has perfected two devices, either of which is capable of annihilating civilization. One is total war; the other is world soil erosion. Of the two, soil erosion is the more insidiously and fatally destructive. War disrupts or destroys the social environment which is the matrix of civilization. Soil erosion destroys the natural environment which is its foundation."

The three books are complementary. Wrench restates the problem and pleads for the recognition of natural laws in the symbiotic relationship of human society to the soil, Ward Shepard presents the American view and urges a practical programme for the American continent based on the recognition of the fact that man does not conquer Nature but at best has the privilege of co-operating, on terms and conditions set by Nature. Edward Roux's modest paper-covered volume is concerned solely with the South African veld—yet of the three it breaks new ground and strikes a new note. National leaders may be aware of the problems, but even the best considered schemes depend for their success on the co-operation of the individual—the ordinary farmer. The T.V.A. had to win the confidence of the local people man by man—an aspect of its successful work far too often overlooked. So Roux has written a little book in the simplest of language—for school-children, farmers and townsmen—illustrated by the simplest of line drawings of veld grasses, of the causes and cures of erosion. The book is a model of its kind because the author does not sacrifice scientific accuracy to 'popular' appeal—he succeeds in a few brief pages in making crystal clear the meaning of plant succession, climax vegetation and the all-important stabilization of seral communities which include the valuable grasses. There is only one criticism: the book ought to cost sixpence in order to secure the widest use—not five shillings.

Ward Shepard sees the solution of the problem in North America through the creation of a nation-wide organisation of land-management districts based essentially on river basins. What he calls "integral watershed development" envisages restoration of vegetation cover combined with drainage and flood control after the now familiar model of the Tennessee Valley. He devotes considerable attention to problems which are domestic rather than world-wide—to demonstrating, for example, that the public acquisition of low-grade land is not necessarily socialism, that authorities such as T.V.A. need not be "undemocratic" and that their powers can be compatible with the maintenance of "States' rights". Unfortunately, he has the too common fault of spoiling his case by overstatement. It is scarcely true to say that "soil stability in Europe was purchased at the expense of the ruthless exploitation of the soils in the new continents"—it is rather that the new lands have had to learn by painful experience the wisdom which is the heritage of the European farmer. However much credit is due to H. H. Bennett—and it is very great—it is scarcely true to say that the menace of soil erosion was not appreciated until the formation of the United States Soil Conservation Service in 1933.

It is difficult to assess the value of Dr. Wrench's book. He confesses himself the product of an English public school where no effort was ever made to arouse interest in the local environment, as a medical student led to ponder, "Why disease ?", and as a student in Germany revolting against the profit motive of a mechanical age. The field he surveys is world-wide: it ranges from a correlation of the rise and fall of Rome with the substitution of slave labour and the development of an urban mentality for an earlier peasant economy, to the Second World War and its inevitable return to subsistence farming. He devotes Chapter 23 to a summary of the preceding chapters and re-emphasizes his admiration of the agricultural systems of ancient Peru, Islam and China. Quite rightly he stresses the supreme importance of returning to the soil what has been taken from it, and abhors the profligate waste of water sewage systems. But like so many others who hold to farming as a way of life, he confuses the abuse of science with its use. Instead of advocating a wise use of new knowledge he sees the only solution in a return to peasantries as the prime cultivators of the soil.

L. DUDLEY STAMP

PREHISTORIC ARCHÆOLOGY OF GUJARAT

Investigations into Prehistoric Archæology of Gujarat

Being the Official Report of the First Gujarat Prehistoric Expedition, 1941–42. By Prof. Hasmukh D. Sankalia. (Srī-Pratāpasimha Mahārāja Rājyābhisheka Grantha-mālā, Memoir No. 4.) Pp. xviii+336+31 plates. (Baroda: Baroda State Press, 1946.) 21 rupees.

THIS volume gives the results of a series of expeditions sponsored by Rao Bahadur K. N. Dikshit and led by Dr. Hasmukh D. Sankalia, with Dr. B. K. Chatterjee and Mr. V. D. Krishnaswami as collaborators. The aims of the expedition were to examine the river beds of Gujarat for the remains of palæolithic man, to investigate certain microlithic sites, and as a result to obtain a sequence of prehistoric cultures for the area. Little had been done in the district since the days of Bruce Foote, and the time was ripe for such investigations to be made.

Gujarat lies in the northern part of the Bombay Presidency. It is bounded to the north by the Aravalli Range and the Marwar Desert; to the west lies the Gulf of Cambay, southwards is the Deccan plateau, while to the east are the gorges of the Narmadā and the Tāpī and the Mewar and Malwa plateaux. Within the area occur many different kinds of geological deposits, some of riverine and some of æolian origin. Considerable archæological finds were made and numerous sections are given. The artefacts include various kinds of *coups de poing*, cleavers, disks, etc. Some 'pebble' tools were also collected, as well as a small 'flake' industry. Judging from the illustrations, it would seem that influences both from the more northern Soan cultures as well as from the early palæolithic (*coup de poing*) cultures of south-east India are present. But it is not easy to judge solely from pictures, especially as these are the weaker spots in an otherwise excellent piece of work. A few reproductions of photographs are necessary as controls, but implements do not photograph well. Frankly, Indian draughtsmen have not yet quite learnt the art of drawing stone tools, especially difficult in these cases when the material used is other than flint or some similar substance. There are so many details the student looks for in the picture. A draughtsman of stone implements must be both an artist and an amateur of the subject. However, the drawings in this volume are much more useful than many that have heretofore illustrated works on Indian prehistory.

The microlithic finds were also very interesting and included skeletal remains which have still to be described in detail. Pottery occurred, at least in the later phases of the culture, as well as some bone tools. No micro-burin seems to have been found; at any rate this type appears to be absent from the catalogue and the illustrations. It remains still necessary, therefore, to demonstrate beyond doubt a great antiquity for these cultures and any connexion either culturally or in time with the true Mesolithic cultures elsewhere.

The volume is well got up and there are many excellent maps and sections. If in future publications the drawings could be still further improved, some really first-class work may be expected. One rather doubts the necessity for such a complete catalogue of every find; a shorter analysis of the various types collected would surely be enough and would make matters easier for the reader. But this, if indeed it is a fault at all, is one on the right side. It is to be hoped that Dr. Sankalia will continue his important investigations. M. C. BURKITT

CHEMISTRY AND NATURE

Annual Review of Biochemistry

Edited by J. Murray Luck, James H. C. Smith and Hubert S. Loring. Vol. 15. Pp. xiii+687. (Stanford University P.O.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1946.) 5 dollars.

IT should be unnecessary to write that the latest volume of the "Annual Review of Biochemistry" will be welcomed by biological chemists, teachers and research workers alike. In no subject is there greater necessity for the teacher to engage himself actively in research than in the fundamental aspects of the chemical processes taking place in the tissues of organisms. In few subjects do we find so vast and stimulating a field; indeed, without the periodic surveys of the "Annual Review" the teacher would stand little chance of keeping himself in the biochemical picture. One may note in passing that the present volume refers to the work of some 3,500 individual workers.

The reviewer considers that the volumes of this series should be, as they all too frequently are not, an important component of the libraries of the purely chemical and purely biological laboratory. In Great Britain there is a tendency still to regard biochemistry as a slightly unrespectable offshoot of medical physiology; how erroneous is this conception may be shown by consideration of the contributors and their articles in the present volume. The past few decades have shown the results of the impact of chemistry upon biology, but the pure chemist does not always realize that a reverse action has also resulted. The modern developments in microchemistry are largely due to the crying needs of the biological chemist who is forced to work on the milligram scale.

Besides the 'hardy annuals', some less frequently reviewed fields are covered in volume 15. "The Biochemistry of Yeast" (Neuberg) provides an unusually useful compilation; among the more exotic facts reported is that an average sample of yeast contains about 1×10^{-7} per cent of uranium. "The Biochemistry of Teeth", "Respiration of Plants", "Photosynthesis" and "Organic Insecticides" are among welcome surveys of branches of study which are not regularly reported. It appears that biochemical investigation in the realm of the higher plants is making slower progress than is parallel work among the animals and micro-organisms. Is this a relic of the developmental history of biological chemistry, or is it the result of technical difficulties in the manipulation of plant tissues? Or is it due to some lack of attraction by this field for the junior research worker? The reviewer is of the opinion that many chemical preparations containing 'marked' atoms may ultimately be most readily achieved through the active intervention of higher plants and micro-organisms. Study of the biochemical processes of the higher plants would thus seem to offer many opportunities.

Among the regular features, the article on "Biological Oxidations and Reductions" stands out by reason of being both readable to the non-expert, and providing a mine of up-to-date information. There is, however, among several chapters, noticeable overlapping; this can be due only to lack of a clear editorial directive to the contributors. "Non-oxidative Enzymes", "Carbohydrate Metabolism", "Metabolism of Proteins and Amino Acids" and "Bacterial Metabolism" provide the worst instances. Since modern studies of metabolic processes have become no less than the study of enzymic mechanisms, sometimes isolated, sometimes integrated, it is clear that such duplications in the "Annual Review" are bound to arise unless the authors are adequately briefed. Such duplications must inevitably have uselessly expended valuable time and labour, but they also waste book-space and disappoint the reader.

Examples of overlap occur in amino-acid decarboxylation, transamination and sucrose phosphorylase. The first is given two pages in one chapter, three and a half pages in a second, one and three-quarter pages in a third and two pages in a fourth. Transamination has two pages, two pages and one and three-quarter pages in three separate chapters. The phosphorolysis of sucrose by a single strain of bacterial enzyme, discussed in volume 14 in three separate chapters, now comes up for rediscussion in no less than four places.

The reviewer believes that the time may now be ripe to separate, into a new review, the regular features of "Nutrition", "Vitamins", "Growth Factors", and "Mineral Metabolism", thus leaving together the more fundamental aspects of biological chemistry. The foregoing criticisms are not put forward in a carping spirit; but in the hope that the "Annual Review of Biochemistry" may continue to improve its position as an indispensable guide to scientific investigators. D. J. BELL

CELLULOSE CHEMISTRY FOR THE STUDENT

An Introduction to the Chemistry of Cellulose

By J. T. Marsh and Dr. F. C. Wood. Third edition revised. Pp. xii+525+23 plates. (London: Chapman and Hall, Ltd., 1945.) 32*s*. net.

THIS work was first published only in 1938, but it is now well established as an authoritative introduction to one of the most complex branches of chemical study. One of the main reasons for its success is, no doubt, the skilful way in which a balance is preserved between the extremes of theory and practice. The nature of cellulose chemistry is such that to achieve this is particularly difficult. Thus, on one side is the substance cellulose itself, with its complex chemical structure still not certain despite a large volume of physical and chemical research. On the other are everyday commodities, such as paper and textiles, which consist principally of cellulose, although the role of this substance in determining their properties is still far from being fully understood. The new-comer to the subject may well be excused a measure of bewilderment when he attempts to correlate these two extremes, but this book will go far towards eliminating it.

The preface to this new edition mentions the strengthening of those portions of the book which refer to the "non-textile aspects of the subject", thereby removing the only real criticism which the present writer felt justified in raising in his review of the last edition. In particular, fuller reference is now made to paper manufacture, brief descriptions of the usual commercial methods of pulping wood being included. Beating is also dealt with briefly (although the subject, as such, does not occur in the index). However, readers whose interests are connected with paper technology may justifiably have expected a fuller treatment of this subject than is possible in the three and a half pages allotted to it, especially in view of the importance of recent work as a guide to the physical structure of cellulose. Holocellulose, now known to be a very important constituent of chemical pulps so far as their behaviour on beating is concerned, is mentioned only as a three-line definition. However, it would be unfair to stress these points too strongly, as the authors have obviously gone to some pains to widen the background of the book, and in other respects they have succeeded in doing so.

The scope of the book follows along much the same lines as those of the previous editions. Part 1 deals with the occurrence in Nature and general physical properties of cellulose. Part 2 discusses its chemical constitution and molecular weight and structure, with special reference to the works of Staudinger and of Mark and Meyer, and to the chain molecule hypothesis. Cellulose dispersed in various reagents is the subject of Part 3; and modified celluloses (especially those produced by treatment with acid or with oxidizing agents) are dealt with in Part 4. Part 5 comprises nearly two hundred pages and deals at length with derivatives of cellulose. Many of these are of considerable commercial importance (for example, as a basis of rayon and high explosives manufacture); others play an important part in studies of the chemical structure and molecular weight of cellulose.

The book ends with density tables, good subject and author indexes, and a list of patent specifications with page references to the text. There is no bibliography, but sources of information, whether books or scientific journals, are mentioned as occasion arises. This is probably the best plan in a book intended as a guide to younger chemists.

The general standard of production of the book is high, and the illustrations are well reproduced. Some additions to the latter (depicting the structures of trees) occur in the new edition. A useful feature is the tables summarizing the effects on the chemical reactions and physical properties of cellulose of 'activation' (swelling) and of degradation. The book may again be recommended to all chemists interested in those branches of industry which are concerned with cellulose.

JULIUS GRANT

THE HUXLEY PAPERS

The Huxley Papers

A Descriptive Catalogue of the Correspondence, Manuscripts and Miscellaneous Papers of the Rt. Hon. Thomas Henry Huxley, preserved in the Imperial College of Science and Technology, London. By Warren R. Dawson. Pp. xii+201. (London: Macmillan and Co., Ltd., 1946.) 25*s*. net.

THE general and scientific correspondence of T. H. Huxley cannot fail to be of interest to a wide circle of students. His correspondents included not only men of science, but also those eminent in almost every field of learning. In 1937, through the Friends of the National Libraries, his correspondence and miscellaneous papers were acquired by the Imperial College of Science and Technology, and afterwards a few additions have been made by private donors. Mr. Dawson was entrusted with arranging, classifying and cataloguing this large mass of documents, comprising some 4,500 letters to and from about 850 correspondents, and the results are presented in the present volume.

The greater part (174 pages) is devoted to scientific and general correspondence. The letters are arranged alphabetically under the name of the correspondent, with the letters of each writer in chronological order. Each entry comprises, so far as possible, the town of origin, date, and a brief summary of the contents of the latter, with figures indicating the volume number and folio of the Huxley papers. Family letters are listed in a separate section, and then follow lists of miscellaneous papers dealing with almost every subject in which Huxley was interested, including notes and materials for many of his lectures and papers. These support Chalmers Mitchell's observation, contained in an appreciation of Huxley written soon after his death, that "His literary style, his brilliant rhetoric and acute disputation came to him slowly; they were the outcome of laborious effort and continual practice."

The papers throw light on the many activities in which Huxley took part, and will be invaluable to biographers and all students of the intellectual development of the nineteenth century. The catalogue is beautifully printed on paper of a quality that has become all too rare in recent years. One or two slight errors in the scientific names are possibly the result of Huxley's very illegible handwriting, and do not detract from the general high standard of this useful work.

E. HINDLE

TYCHO BRAHE (1546–1601)*

By Sir H. SPENCER JONES, F.R.S.
Astronomer Royal

During the Middle Ages, the long period that elapsed between the fall of the ancient civilization and the Renaissance, scarcely any progress was made in astronomy in the Western world. The theory of the universe which was almost universally accepted during these centuries was the cosmology of Aristotle; superposed upon this was the Ptolemaic system of epicycles and deferents, which provided a mathematical representation of the movements of the planets, on the basis of which their positions could be computed and published in the ephemerides

Copernicus brought about a great revolution in outlook by placing the sun at the centre of the universe and assuming the earth to revolve around it and to rotate on its axis. A considerable simplification of the Ptolemaic system resulted; but Copernicus was still tied to the old idea of circular motion and was compelled to retain many of the epicycles and deferents of Ptolemy in order to account for the observed movements of the planets. In his day, the objections to the movement of the earth seemed strong, for the principles of dynamics had not been formulated; the Aristotelian idea that the solid earth was in the centre of the universe because all heavy things moved downwards towards the centre seemed common sense. So the philosophic point of view of the Copernican theory was slow in gaining acceptance, though it was found convenient to use it as a mathematical representation of planetary motions. The Prutenic Tables, based upon the Copernican theory, were an improvement upon the Alphonsine Tables, based upon the Ptolemaic theory.

Copernicus was primarily a mathematician and philosopher; he made but few observations and did not add many facts to natural knowledge. The errors of the Prutenic Tables were considerable; Copernicus had told Rheticus that he would be pleased if he could make his theory agree with observations to within 10′; but, in fact, the errors of the theory could be as large as a few degrees. The available observations were too few in number and their errors were too large either to determine with sufficient accuracy the fundamental numerical constants necessary for the development of any theory, or to enable the theory to be adequately tested by observation.

The prime need of astronomy was a large stock of observations of a higher degree of accuracy. This need was met by the work of the great Danish astronomer, Tycho Brahe. Though he himself did not accept the Copernican system, his accurate and systematic observations provided the proof that some of the fundamental ideas of the Aristotelian cosmology were not tenable, and enabled Kepler to express the true laws of planetary motion in Copernican terms. The work of Kepler and the discoveries of Galileo completed the revolution in thought which Copernicus had commenced, and compelled the abandonment of ideas which had been universally accepted for fourteen centuries.

Tycho Brahe was born on December 14, 1546, at Knudstrup in Scania, the southernmost province of the Scandinavian Peninsula, which then belonged to Denmark. He was the second child and eldest son of Otto Brahe, a member of an ancient noble family, who later became a privy councillor, lieutenant of various counties and then governor of Helsingborg Castle. His mother, Beate Bille, was afterwards made Mistress of the Robes to Queen Sophia of Denmark. His father's brother, Jorgen Brahe, who was childless, had been promised by Otto that if he had a son Jorgen could bring him up as his own. The fulfilment of this promise was claimed in vain, but when a second son was born Jorgen carried off Tycho by stealth. He was brought up at his uncle's seat at Tostrup until, at the age of twelve, he was sent to the University of Copenhagen to study rhetoric and philosophy, as being most necessary to the career of a statesman, for which he was destined by his uncle. An eclipse of the sun on August 21, 1560, visible in Copenhagen as a partial eclipse, attracted the boy Tycho's attention because it had been predicted. He had already begun to take an interest in astrological predictions, and he now became curious about astronomical matters. He bought a copy of the works of Ptolemy, and with its study his interest in mathematics and astronomy grew.

Jörgen Brahe did not look with favour on his nephew's scientific interests. So, in 1562, he sent him to the University of Leipzig with a young man, Anders Vedel, as tutor. Vedel, who later became Royal Historiographer, had the task of seeing that Tycho's studies were such as befitted a nobleman. Tycho, however, sought the acquaintance of the professor of mathematics and continued his study of astronomy surreptitiously. He bought a small celestial globe from which, when Vedel was asleep, he learned the names of the constellations. He procured a copy of the Alphonsine Tables, based on the Ptolemaic system, and of the Prutenic Tables, based on the Copernican system, and, when only sixteen years of age, perceived that neither agreed with the true positions of the planets, the errors of the Alphonsine Tables being the greater; for these first observations he used a pair of ordinary compasses for the rough measurement of the angular distances between planets and stars. He observed the close conjunction of Saturn and Jupiter on August 24, 1563, and found that the Alphonsine Tables were a whole month, and the Prutenic Tables a few days, in error as to the time of conjunction. Vedel gradually came to recognize that the love of astronomy was so deeply rooted in his pupil that it was impossible to force him against his will to the study of things in which he was not interested.

The first indication of Tycho's innate practical talent was shown in 1564. He had provided himself with a 'radius' or 'cross-staff', in order to obtain more accurate observations, and he soon discovered that the graduations on the staff did not give the correct angles. He tried to get money from Vedel for a better instrument and, on this being refused, he proceeded to construct a table of corrections to be applied to his observations.

Soon after Tycho's return to Denmark in 1565 his uncle died and, as his relatives and other nobles looked with disfavour on his taste for star-gazing in preference to more usual occupations, he soon left again for the University of Wittenberg; but after a short while an outbreak of plague caused him to go to Rostock. There in a duel he lost part of his nose which, in order to conceal the disfigurement, he replaced by a substitute, made of a composition of gold and silver.

* Lecture delivered at the Royal Institution on November 26.

Tycho's zeal for astronomy must have attracted notice, for in May 1568 King Frederick II promised him the first vacant canonry in Roskilde Cathedral, the incomes of canonries being frequently used at that time to support men of learning. After some further travels he came to Augsburg in April 1569, where he made the acquaintance of two brothers, Johann and Paul Hainzel, who were interested in astronomy. Tycho had come to the conclusion that larger instruments than those with which astronomers then observed were needed to increase the accuracy of observation, and he supervised the construction for the Hainzels of a large wooden quadrant of about 19 ft. radius. He also designed a sextant for measuring angles in any plane, with which he made some observations, and he arranged for the construction of a large celestial globe, 5 ft. in diameter, made of wooden plates and covered with thin gilt brass sheets. The stars and the equator and colures were marked on it, and Tycho used it in later years for the quick solution of spherical triangles.

In 1570 Tycho returned to Denmark, probably on account of the illness of his father, who died in May 1571. He took up his abode with his mother's brother, Steen Bille, near Knudstrup, and seems to have laid aside the study of astronomy in favour of chemical experiments, until the event occurred which finally and irrevocably turned his mind to practical astronomy.

On the evening of November 11, 1572, Tycho was returning to the house from his laboratory for supper when he was startled at seeing an extremely bright star in the constellation of Cassiopeia, where, as he well knew, there had been no bright star before. He could not believe his eyes and thought it must be some strange trick of the imagination. He had recently completed a new sextant, made of walnut wood with arms $5\frac{1}{2}$ ft. long, and with this he at once proceeded to measure the angular distances of the new star from the nine principal stars in Cassiopeia. The star continued to be visible for about eighteen months. When first seen it was as bright as Venus at its brightest and was easily visible to the naked eye in broad daylight. During November it continued to shine with undiminished lustre and then began slowly to fade until, in March 1574, it ceased to be visible. During the time the star was visible its colour underwent a succession of changes from white to yellowish and then to a ruddy hue.

Tycho applied a variety of methods to find whether the star had an appreciable parallax. He was unable to detect any parallax, and the conclusion drawn from his observations was that the star was more distant than Saturn and was in the firmament itself. This may seem to us a fairly obvious conclusion, but in his day it was a cardinal principle that, in accordance with the doctrines of Aristotle, the regions beyond the moon and of the fixed stars in particular were unchangeable and incorruptible. Tycho's observations of the new star proved for the first time, beyond possible doubt, that this doctrine could not be sustained.

Tycho prepared a manuscript account of his observations of the new star and of his deductions from them, with some account of its probable astrological significance. When he showed it to some of his friends, they urged him to have it printed. At first he declined, because there was a prejudice among his fellow nobles that it was not proper for a nobleman to write books. But when other accounts of the star, both written and printed, came into his hands, many of which contained a great deal of nonsense, and when publication was urged by his kinsman, Peter Oxe, the high treasurer of Denmark, he yielded. The little book, "De Nova Stella", was printed in Copenhagen in 1573. Not many copies were printed and the book is now extremely scarce. The more important parts of it were reprinted in his greater work, "Astronomiæ Instauratæ Progymnasmata", on which he was engaged during the last fourteen years of his life, and which was published in 1602 after his death.

After the publication of his book, Tycho had intended to go abroad for some time, but the journey was put off, possibly because he had formed an attachment to a young girl, named Christine. Not much is known about her, except that she was not of noble birth. Tycho was never formally married to her, but according to ancient Danish law, a woman who lived with a man, kept his keys, and ate at his table, was after three winters considered as his wife. Some years after his death, his sister Sophia and other relations signed a declaration that his children were legitimate. He had eight children in all, of whom two died in infancy. Tycho's relations considered the connexion a disgrace, not because he was not married to the girl but because she was of lowly birth, and they became estranged from him.

Early in 1575 Tycho at last started on his long-deferred journey in Central Europe. At Cassel he met a kindred spirit in the Landgrave William IV of Hesse, an enthusiastic astronomer, who had his own observatory; though Tycho never saw him again after this visit, the two men maintained a frequent correspondence and interchanged observations. After travelling in Germany, Switzerland and Italy, and meeting many astronomers, Tycho returned home at the end of 1575 with the intention of settling down in Basle; the central situation of Basle was convenient, and its University was one of the most important centres of learning in Europe.

But luckily at this juncture, King Frederick II had his attention directed to Tycho by the Landgrave William, who urged him to do something for Tycho so as to enable him to devote himself to astronomical studies in Denmark, which would not only advance science but would also bring much credit to the king and to his country. The king, for his part, was a patron of learning and was only too anxious to keep so promising a man as Tycho in his kingdom. The upshot was that he made Tycho such an attractive offer that Tycho altered his plans and decided to remain.

The chief part of the King's gift was the island of Hveen, situated in the Sound about fourteen miles north of Copenhagen, where Tycho could pursue his studies undisturbed by affairs of court and State. The document signed by the King granted "to our beloved Tyge Brahe . . . our land of Hveen, with all our and the crown's tenants and servants who thereon live, with all rent and duty which comes from that, and is given to us and to the crown, to have, enjoy, use and hold, quit and free, without any rent, all the days of his life, and as long as he lives and likes to continue and follow his *studia mathematica*, but so that he shall keep the tenants who live there under law and right, and injure none of them against the law or by any new impost or other unusual tax". The King also gave Tycho a sum of money to build a house on Hveen, and granted him an annual pension of 500 daler.

Further sources of income were provided in subsequent years. In 1577 he was granted the manor of Kullagaard in Scania, to be held during the King's pleasure, on condition that he kept the lighthouse of Kullen in order. In 1578 the use of eleven farms in the country of Helsingborg, free of rent, was given him. In the same year he was given the income of an estate at Nordfjord in Norway, until the canonry at Roskilde, of which he had been promised the reversion, became vacant. This occurred in 1579, when the canonry was conferred on Tycho, with certain obligations, including keeping the chapel of the Holy Three Kings, to which the canonry was attached, in proper repair; but he was allowed to keep the Nordfjord estate. There were from time to time some variations in and additions to these marks of the King's generosity; but during the years he lived at Hveen, Tycho enjoyed an income which, according to his own statement, amounted to about 2,400 daler a year, equivalent to about £550, a considerable sum in those days, which should have been amply sufficient for his needs.

Tycho at once set about building a residence and observatory, which he named Uraniborg, as it was to be devoted to the study of the heavens. The foundation stone was laid on August 8, 1576, but the building was not completed until 1580, though Tycho had taken up his residence there some time previously. The edifice was a palatial structure of red brick with sandstone ornaments, in the Gothic Renaissance style. The principal and central portion was in the form of a square, 49 ft. long, in two stories, containing living-rooms, library and laboratories, with eight small attic rooms above for students and assistants. On the north and south sides were round towers, 18 ft. in diameter; smaller towers on the east and west sides contained the entrances. The two main towers each had a platform on the top, surmounted by a pyramidal roof, forming an observatory. There were numerous smaller observatories. It was situated at the centre of a large square enclosure, formed by earthen walls, 18 ft. high and 16 ft. thick at the base, with the corners pointing to the four points of the compass. There were entrances at the east and west angles, and mastiffs were kept in small rooms over the gateways to announce, by their barking, the arrival of visitors. The enclosure was laid out with gardens and orchards.

In 1584, when the number of assistants and pupils had increased, and more instruments were needed, Tycho erected a second building to the south known as Stjerneborg or Star Castle, containing five underground instrument rooms, with only the roofs above ground, so that the instruments were well protected from the wind, and with a study in the centre. Subterranean passages connected the various rooms. On the walls of the study were the portraits of eight astronomers, all in a reclining posture, Timocharis, Hipparchus, Ptolemy, Albattani, King Alphonso, Copernicus, Tycho, and an astronomer yet unborn, his hoped-for descendant, Tychonides. He also established workshops, where most of his instruments were made, and installed his own printing press and even a paper mill, so that all essential work could be carried out on his own premises.

Tycho constructed a great variety of instruments, some of which were large and fixed while others were smaller and portable, so that Uraniborg had the most magnificent collection of instruments that had ever been seen. He had several quadrants, movable in azimuth, the largest having a radius of 7 ft., with a large azimuth circle; a variety of sextants for measuring the distances between celestial bodies; a large equatorial instrument; a large mural quadrant, which was his own invention, of $6\frac{3}{4}$ ft. radius; as well as various astrolabes, armillary spheres and other instruments. These instruments were constructed with great care to give as high an accuracy as possible in observation. They were made mainly of metal, whereas wood had previously been generally used. The errors of the instruments were determined, and corrections for the errors were applied to the observations. The accuracy of reading was increased by an improved method of graduation by means of transversals, in which graduations made alternately on each side of a pair of parallel arcs were joined diagonally by series of equally spaced dots; in some cases the graduations were subdivided in this way to every 10″. Improved sights were used to increase the accuracy of setting.

The observatory possessed some clocks, which had the verge escapement and foliot balance arm, which was usual at that time, before the invention of pendulum clocks. Their time-keeping properties were very poor; this was realized by Tycho, and he did not make much use of them in his observations. The mural quadrant was employed mainly for measuring meridian altitudes and not as a transit instrument. Tycho adopted an ingenious method for determining right ascensions which did not require the use of clocks. The meridian altitudes of two stars were observed with a quadrant, giving their declinations, and the distance between the two stars was measured with a sextant. The three sides of the spherical triangle formed by the Pole and the two stars being known, the difference of the right ascensions of the stars could be computed. In order to determine absolute right ascensions, it was necessary to refer the stars to the sun; for this purpose he used Venus as an intermediary. When Venus was sufficiently bright, he measured the distance between Venus and the sun, as well as their meridian altitudes, enabling him to derive the difference in right ascension between the sun and Venus. Then after sunset, he measured the distance of Venus from several bright zodiacal stars, and also the meridian altitudes. By allowing for the motion of Venus in the interval, the difference in right ascension between sun and star was obtained. These zodiacal stars were then connected with α Arietis, near the vernal equinox, each observation giving a value of the right ascension of this star. By proceeding round the heavens, the right ascensions of four, then of six, and finally of eight principal standard stars were derived. Other stars were connected with two or more of these standard stars, at least one of which was preceding and another following the star. In this way his catalogue of star positions was built up; the probable error of a position of a standard star in each co-ordinate was about $\pm$ 25″, which was a very considerable advance on the accuracy with which star positions had been previously determined.

An important contribution made by Tycho to positional astronomy was the detection of the effect of atmospheric refraction and the determination of its amount. He found that the latitude derived from the measurement of the meridian altitudes of the sun at the two solstices differed from the latitude deduced from observations of the Pole star. Having satisfied himself that the discordance was not produced by instrumental errors, he was led to explain it as the effect of refraction. He then investigated the amount of the refraction by measuring the altitude and azimuth of the sun at frequent intervals throughout a whole day, near the summer solstice when its declination was practically stationary, during the years 1585–89. From the observed azimuth, knowing the declination and the latitude, he could compute the altitude of the sun, and comparison with the observed altitude gave him the amount of the refraction. His measurements of the refraction were, however, vitiated by assuming the parallax of the sun to be 3′, the value which had been used since the time of Hipparchus. This was the only astronomical quantity which Tycho borrowed from his predecessors. It is somewhat surprising that he did not attempt to determine it for himself; he would have found that for his instruments it was insensible.

Tycho lived at Hveen in magnificent style, with little attention to economy. The expenses of the establishment were very great and he was not infrequently in debt. Perhaps because of this, he continually neglected the obligations under which he held several of his tenures; he neglected the maintenance of the lighthouse of Kullen; he treated his tenants in an arbitrary manner with the haughtiness of a medieval nobleman, illegally forcing work from them for which they were not liable; he neglected the upkeep of the chapel which his canonry required, did not arrange for the conduct of the chapel services, and defaulted on certain payments to the widow of the previous holder, for which he was liable. There were frequent quarrels, disputes, and complaints, in which the King often had to intervene, several times paying the sums in dispute in order to settle the matter. Tycho entertained numerous distinguished visitors, who were attracted to Hveen by his growing fame; these included James VI of Scotland and several members of the Danish royal family.

Nevertheless, astronomical work was carried on assiduously. For the employment of the many instruments and for the extensive computations involved, considerable assistance was needed. During the twenty-one years that Tycho spent at Hveen, at least forty pupils and assistants, and probably many more, were employed there at one time or another.

In November 1577 a brilliant comet appeared and remained visible for more than two months. Tycho observed it diligently with his customary care, and proved beyond doubt that it had no perceptible daily parallax and that it was situated far beyond the moon's orbit. He thus gave another severe blow to the Aristotelian doctrine that comets were exhalations in the atmosphere of the earth, a view which he had formerly himself held. Tycho also made observations of the comets of 1580, 1582 and 1585, which served to confirm his conclusions. A full account of the observations of the comet of 1577 is given in the "Astronomiæ Instauratæ Progymnasmata". In the course of this work he considers the orbit of the comet and explains his views about the construction of the universe, which he had developed in 1583. Though Tycho recognized the great mathematical superiority of the Copernican system over the Ptolemaic system, he could not accept the motion of the earth. The physical objections to this motion, in the days before Galileo had laid the foundations of mechanics, seemed too strong. The motion of the earth was also against Scripture. But his strongest objections were against the immense distances and incredible sizes of the fixed stars, which the Copernican system involved. Making use of the old value of the solar parallax of 3′, he concluded that the sun had 5·2 times the diameter of the earth. He grossly over-estimated the apparent diameters of the stars, assigning a diameter of 2′ for a first-magnitude star, a value appreciably smaller than the diameters assumed by most other astronomers before the invention of the telescope. On the Copernican system, the absence of any detectable annual parallax of the fixed stars made it necessary to accept that they were far beyond Saturn; Tycho concluded that, if the earth really moved round the sun, stars of the first magnitude must exceed in dimensions the whole amplitude of the earth's orbit, which seemed to him absurd

He therefore formulated a new system. He placed the earth immovable in the centre of the universe. The moon circled around the earth and, at twenty times the moon's distance, the sun also. But the five planets moved in orbits centred at the sun, which were carried around the earth with the sun. Just outside the orbit of Saturn, the finite sphere of fixed stars rotated once every twenty-four hours. The orbits of Mercury, Venus and Mars intersected the orbit of the sun about the earth, which would have been impossible on the Aristotelian doctrine of solid crystalline spheres. One more long-held conception thus had to be discarded. The comet was supposed by Tycho to move around the sun in a circular orbit outside that of Venus, in the direction opposite to that of the planets. This involved difficulties, because in order to represent the observed positions, he had to assume a variable rate of motion. He remarked that the introduction of an epicycle might account for this, but that probably ephemeral bodies like comets do not move with the same regularity as planets.

This system avoided the most serious criticisms to which the Copernican system was subjected, but preserved all its mathematical advantages, the two systems being essentially identical mathematically. As the Ptolemaic system became increasingly indefensible, the Tychonic system became acceptable to those who were unwilling to accept the Copernican system. It thus served as a stepping-stone from the Ptolemaic to the Copernican system and, though Tycho himself did not accept the latter, his work greatly helped to secure its ultimate acceptance.

Tycho was extremely proud of his system, which was the cause of a violent quarrel with Reymers Bar, who developed, probably quite independently, a system very like Tycho's but accepting the rotation of the earth, which he published in 1588. Reymers had been at Hveen for a short time in 1584, and Tycho accused him of having stolen the idea from some of his manuscripts. Reymers retaliated with a counter-charge of theft against Tycho, and the quarrel was only terminated by the death of Reymers in 1600.

In 1588, the year of the publication of the book on the comet of 1577, King Frederick died. His eldest son, Prince Christian, being only eleven years of age, a regency of four protectors, elected from among the nobles, was formed. They were friendly to Tycho and paid off for him a debt of 6,000 daler which he had incurred; they also undertook to keep the buildings at Hveen in repair at the public expense. In 1592 the young king-elect paid a visit to Hveen. But the continued neglect by Tycho of obligations under his tenures and his high-handed and arbitrary acts towards his tenants gradually undermined his position in Denmark. The death in 1594 of the Chancellor, Niels Kaas, who was one of the four protectors and a powerful friend of Tycho, made his position less secure. Tycho began to entertain thoughts of leaving Denmark and, perhaps with this in view, disposed of his portion of the family estates at Knudstrup. In 1596 King Christian was declared of age and crowned at Copenhagen. He was of an economical disposition and soon began to introduce economies. He was not interested in astronomy like his father; he no doubt regarded the heavy expenditure at Hveen as an extravagance. Tycho lost first his Norwegian fief, and then the pension of 500 daler. His position at Hveen finally became untenable. Observations were discontinued in March 1597, and in the following month he left the island where he had worked for twenty-one years, removing his furniture, his printing press and his instruments, with the exception of the four largest ones, which were left behind temporarily as being too troublesome to move. Almost immediately, Tycho was deprived of his canonry, which was given to his enemy, the new Chancellor, Friis. He spent the winter at Rostock, and while there he prepared and printed a description of his instruments, together with a short account of his life and of his principal discoveries, under the title of "Astronomiæ Instauratæ Mechanica". He also prepared and circulated some copies of his catalogue of 1,000 stars; only 777 of these had been adequately observed, the remainder being added, though insufficiently observed, to make up the number.

After some wanderings, Tycho sought and obtained the patronage of the Emperor Rudolph II, a man deeply interested in science but thoroughly incompetent in the management of public affairs. The Emperor granted him a salary of 3,000 florins a year and promised him a hereditary estate whenever one should fall to the crown. Tycho arrived in Prague in June 1599; but, not wishing to live there, he was given the choice of three castles, and selected Benatky, on the River Iser, about twenty-two miles north-east of Prague. He immediately began altering the building and constructing an observatory and a laboratory. His family joined him, and he sent for his other instruments, including those left at Hveen, but there were many delays in transport and they did not reach Prague until November 1600. Funds for the alterations proved difficult to obtain, as the Bohemian exchequer was always empty; so in July 1600 Tycho left Benatky and returned to Prague, eventually moving into the house of the late Vice-Chancellor Curtius, which the Emperor purchased from his widow.

Tycho was meanwhile endeavouring to obtain assistants. He entered into negotiations with Johann Kepler, who was then about twenty-nine years of age and professor of mathematics at Gratz, and had gained a considerable reputation by the work, "Mysterium Cosmographicum", in which he derived a relation between the distances of the planets and the five regular polyhedra. Kepler, as a Protestant, was obliged to leave Gratz when the Archduke Ferdinand vowed to root out all the heretics from his dominions. Arriving in Prague early in 1600, he joined Tycho at Benatky. Kepler was given the theory of Mars to investigate, but trouble soon developed between him and Tycho because he was treated as an ordinary assistant and not as a man of recognized scientific standing. He left Benatky and returned to Prague. But through the mediation of Jessenius, a mutual friend, a reconciliation followed. Kepler's position was for a time insecure, but eventually he was promised the office of Imperial mathematician on condition that he should work with Tycho on the new planetary tables, which Tycho had received the Emperor's permission to call the Rudolphine Tables.

The observations made in Bohemia were on a limited scale, in the first instance because of the long delays in the arrival of the instruments; and then after their arrival, most of them were stored in the basement of Curtius's house until an observatory could be prepared for them, and were not, in fact, ever used again. But considerable work was done in the preparation of observations for publication and in their discussion, as well as in investigations of lunar and planetary theories. Some important discoveries in the theory of the moon were made Hipparchus had discovered the equation of the centre and Ptolemy had discovered the evection, these being the two principal inequalities in the moon's motion. Tycho discovered two further inequalities. One arises from the variation in the magnitude of the residual solar attraction on the earth–moon system during a synodic month, and vanishes at opposition, at conjunction, and at quadratures; it is known as the variation. The other is due to the annual variation of the earth's distance from the sun, and is known as the annual equation. He also discovered that the inclination of the moon's orbit to the equator had a small regular oscillation and that the motion of the moon's nodes was variable. These contributions to lunar theory were made possible because Tycho did not confine his observations to the times when the moon was near opposition, conjunction or quadrature, but observed the moon throughout her monthly course, both on and off the meridian.

Among the many other contributions made by Tycho, mention may be made of his determinations of the constant of precession, of the annual motion of the sun's apogee, and of the length of the year, which were all more nearly correct than any previous determinations. He also disproved the reality of 'trepidation', a supposed oscillatory motion of the equinoxes along the ecliptic, which the Arabian astronomer, Tabit ben Korra, claimed to have discovered about the year A.D. 900, and which had been universally accepted, even by Copernicus.

During the year 1601, Tycho's health was failing, and towards the end of the year he was seized with an illness which, after a few days, terminated fatally on November 24, 1601. Before he died he begged Kepler to finish the Rudolphine Tables as soon as possible, and expressed the hope that he would demonstrate their theory according to the Tychonic system and not by that of Copernicus. Kepler obtained possession of his observations, which have never been published except in an imperfect form.

The elaborate buildings on Hveen did not long survive. Neglected after Tycho's departure, they soon began to fall into ruin, and in 1623 were mostly pulled down to build a new dwelling-house on the site of Tycho's farm. By the middle of the century, nothing remained except the foundations of Uraniborg and the great earthen walls which enclosed it. The instruments were claimed by Tycho's son-in-law and former assistant, Tengnagel, and Kepler was disappointed in his hope of continuing observations with them. They were stored in a vault under Curtius's house, where they remained until they were destroyed in the disturbances which followed the rising of the Bohemians against the House of Hapsburg. But their great work was done; the invention of the telescope soon made instruments of the type used by Tycho obsolete.

Tycho's greatest heritage was his large stock of observations, and these were fortunately safe in Kepler's keeping. The circumstances which made Tycho decide to leave Hveen proved a blessing in disguise, for otherwise Kepler would never have been given the opportunity his genius demanded. The observations of Tycho provided the material which enabled Kepler to formulate his famous laws of planetary motion. The deduction of these laws was made possible by the care which Tycho had always taken to obtain the greatest accuracy of which his instruments were capable, and by the systematic manner in which his observations were made. The prevailing custom had been to make a few observations near opposition or conjunction, and at other times only when required to supply some particular datum needed for a point of theory. But Tycho observed the moon and planets all round their orbits, both on and off the meridian, and the sun almost daily for many years.

Tycho was a man with many faults. We cannot admire his imperious, overbearing manner, his grasping character, his failure to carry out his obligations, his treatment of his tenants, his quarrelsome disposition. But of his life-long devotion to astronomy there is no question. In practical and spherical astronomy he made the first great advance since the days of the Alexandrian school. He realized that the discovery of the true motions of the heavenly bodies could be achieved only by a large stock of observations made with all possible accuracy; by the construction of improved instruments, by scrupulous care in making his observations, and by his unwearied labours, continued for many years, he opened a new era in astronomy. He is justly regarded as one of the greatest astronomers of all ages.

GERMAN PHYSICAL SOCIETY IN THE BRITISH ZONE

GÖTTINGEN MEETING

THE first meeting of the reconstituted "German Physical Society in the British Zone" took place at Göttingen on October 4, 5 and 6, the new Society actually being founded on October 5.

Because of difficulties of transport and accommodation, only about five people attended from each of the nine universities and technical high schools now operating in the British Zone. A few physicists from Berlin were also present, and the meeting gained a slightly international character through the presence of a few British and Dutch men of science. Altogether, approximately 150 people attended the meetings, which were held in the large lecture hall of the Rockefeller Institute for Applied Mathematics at Gottingen; many lively discussions on a smaller scale took place in the Physics Department of the University.

One could scarcely fail to be impressed by the number of German physicists who had managed to keep their fundamental research work going right through the War, and to maintain it under present conditions. Perhaps this may indicate the failure of the Nazi Government to ensure the collaboration in military research of certain of their most important scientific workers, even under the urgent stress of war. This applies in particular to the physicists now working or residing at Gottingen, which at present is unquestionably the most important centre for physics in the zone, due both to its undamaged condition and the valuable old traditions. Of the well-known physicists now living there and participating in the meetings one might mention Planck, v. Laue, Pohl, Heisenberg, Becker, O. Hahn and Kopfermann.

The foundation meeting of the new Society was not remarkable except for one or two points. It was felt to be essential to make a fresh start rather than to attempt to continue the old German Physical Society, since the latter was taken over (*gleichgeschaltet*) by the Nazis, an event which did not take place, however, until 1938. As an incident illustrating the resistance offered to the Nazis by the Society, the fact was mentioned that when J. Stark insisted in 1933 on becoming president of the Society, no more than two votes were cast in his favour. The president of the new Society is Prof. v. Laue.

It is impossible to attempt to give a complete report of all contributions to the meeting, and some of the more interesting ones will therefore be selected. An essential part of the meeting was felt to consist in the private discussions and demonstrations at the University laboratory.

Lauterjung reported on changes in sensitivity of Geiger–Muller counters to ultra-violet light of wavelength 313 mμ, brought about by illumination with γ-radiation. The counters consisted of magnesium, filled with a mixture of argon and neon. The γ-radiation caused an increase in the magnitude of the electric pulses, but no change in the number of pulses for a given ultra-violet illumination. A temporary increase in sensitivity was caused also for α-particles which were used as a control in the experiments; the sensitivity towards light, after a slight initial fall from the first high level reached by irradiation with γ-rays, remained at an increased value of the order of twice the initial sensitivity.

Meyer presented a paper on a proportional Geiger–Müller counter to be used for energy measurements of ionizing particles. The volume of this counter is sufficient to ensure that the particle comes to a complete stop inside the measuring volume. The calibration procedure is ingenious: a window is arranged on the side of the counter, with an electrode outside supplying a field which ensures that the missing part of the wall is at the same potential as the wall itself. In the calibration procedure, α-particles are allowed to pass across the gap in the wall, outside the counter; the central part of their path supplies a known number of ions within the counter. The ionization of the particles to be measured is easily determined by an arrangement of two gas-filled relays connected in opposition and working together into a mechanical counter. Particles of low energy will not affect any of the relays. With particles of increasing energy, one of the relays will operate and work the mechanical counter; with even faster particles both relays will operate, and since they are connected in opposition on the output side, the counter will not respond. The combination of relays thus constitutes an 'energy slit' which can be moved through the energy spectrum merely by altering the grid-bias voltages of both relays.

The age of the earth was discussed by Houtermans. His considerations were based on the relative prevalence of various isotopes of lead, with atomic weights of 206, 208 and 209, originating from U^{238}, Th^{232}, and U^{235} respectively. On this basis, the age of the earth comes to $2 \cdot 9 \times 10^9$ years, with an accuracy of $\pm 0 \cdot 3 \times 10^9$. This is in good agreement with results by Koszy and Wefelmayer based on the total amount of lead present in the earth's crust.

The data underlying these considerations were obtained by means of the semi-routine mass spectrometer developed at Göttingen by Kopfermann. It was claimed that this instrument is much more simple in use and cheaper than any at present available or described. Commercial production of it is contemplated if conditions permit. The success of the instrument is largely due to the principle of producing the ionized particles by electrons oscillating up to a hundred times in the ion gun. In this way a high degree of ionization, often up to 90 per cent, is achieved, and a mass spectrum in the form of a cathode-ray oscillogram can be obtained with very small amounts of substances.

Another instrument demonstrated was a small mass spectrograph used for isotope separation. Amounts up to 0·5 mgm. of certain isotopes can be obtained in twenty-four hours, which is often sufficient for biological experiments with tracer elements. The results of such experiments were investigated by means of the mass spectrometer mentioned above. This collaboration between physicists and biologists is at present impeded by zone boundaries and other difficulties, but is regarded as a very promising line of research.

Similar collaboration between physicists and biologists has centred around the electron miscroscope. This instrument is not fully occupied by problems arising in the physics departments alone, but is now being fully utilized in collaboration of this kind.

From R. W. Pohl's laboratory, Mollwo reported on the density of vacuum-deposited salt layers. An elegant micro-balance was made up from the parts of a moving-coil instrument, the current through this instrument being used to counteract the increase in weight of the support of the salt layer. Precautions are necessary to eliminate the effect of stray electrical charges; when this is done, the sensitivity of the method is considerable. The thickness of the deposited layers is determined by an interference method best described as a reversed Lummer–Gehrke system: the light falls on the layer at glancing incidence, and the interference fringes formed become visible due to any scattering particles present in or on the surface under investigation. All measurements are carried out in the same vessel in which the layer is deposited, without disturbing the vacuum. Applying these methods to layers of magnesium oxide, it was found that the density of the deposited layer is lower than that of the solid. The porosity of such layers was demonstrated by breathing on them, when the interference fringes shift. It was worthy of note that coherent layers of magnesium oxide could not be formed unless a very small amount of a nucleating material was first deposited on to the support. For this purpose, metallic copper was found most useful.

This porosity is of interest in connexion with other investigations on the secondary photo-electric conductivity in magnesium oxide. The permanent secondary conductivity, caused by illumination with light of the appropriate wave-length, is connected with a chemical reaction characterized by the release of oxygen. Mass action considerations apply; that is, the reaction can be impeded by increasing the external oxygen pressure.

König reported on other work on the structure of thin evaporated layers, as investigated by electron and X-ray diffraction. For years now there has been an argument about the lattice constants of the very small crystals first formed on deposition *in vacuo*, various authors reporting differences between small and large crystals of the order of 6 per cent. It was now demonstrated that these discrepancies are due to faulty calibrations of the electron diffraction apparatus, which in many instances was carried out using gold leaf, assuming this to be pure gold. Gold leaf actually contains up to 5 per cent copper, apart from other impurities. Using a twin diffraction camera giving simultaneously the pattern due to a calibration substance and that under test, it was shown that there are no discrepancies between the lattice constants of small and large crystals. Experiments have been done with silver, gold, copper, iron, germanium, zinc oxide, copper oxide, potassium bromide and lithium fluoride; the accuracy of the electron diffraction experiments was stated to be one per mille in terms of the lattice constants.

Another investigation by König dealt with the size of the crystallites necessary for ferro-magnetism. Very small iron crystals were obtained by vacuum deposition on to a cooled surface. The size of the crystals could be controlled by the temperature of the receiving surface. The magnetization was measured in the same apparatus, without disturbing the vacuum, by determining the magnetic Faraday effect of the layer; the size was found by electron diffraction methods. Two results of considerable interest were obtained. The smallest crystal which still exhibits ferro-magnetism consists of about 64 atoms. This is thought to indicate that it is necessary to have one completely 'shielded' unit cell in which the spins can orientate themselves. The other finding concerns the shapes of the smallest crystallites formed by deposition on a surface kept at sufficiently low temperature which appear to consist of unit cells, lying in haphazard orientation in the deposited layer. The process of crystal growth occurring on warming up would then consist in the re-orientation and alignment of unit cells. These results were obtained not only with iron and other metals, but also with ionic crystals.

Justi has made a survey of a large number of elements with respect to their super-conductivity, and has found a few new super-conductors. Superconductivity of sodium and potassium is not certain; rubidium, cæsium, erbium, silicon, tellurium and molybdenum do not exhibit it. Rhenium becomes superconductive at 0·90° K. and uranium at 1·25° K. Ruthenium was also stated to be a super-conductor. Although Justi confined his considerations to elements, an interesting recent finding by the brothers Farkas was mentioned in the discussion, according to which a solution of sodium in ammonia becomes superconductive at $-100°$ C.

Heisenberg reported on a new theory of superconductivity according to which a small proportion of the free electrons in a metal, namely, those near the surface of the Fermi distribution, form below the transition temperature an ordered structure or superlattice. The distance between the electrons forming this super-lattice will amount to many times the lattice spacing. When this lattice is formed, scattering processes are impossible and a lowest state with current can occur. The theory suggests that all metals can become super-conductors, that the low value of the transition temperature is to a certain extent accidental, and that it is not out of the question that materials may exist for which this temperature is much higher than usual.

N. F. MOTT

ANTI-TUBERCULAR COMPOUNDS

By Dr. VINCENT C. BARRY

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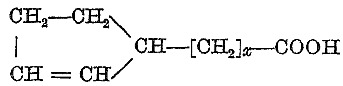
IT is not possible in a short article to mention all the types of substances, organic and inorganic in character, active *in vitro*, which have been tested against tuberculosis experimentally induced in animals. One encouraging fact emerges from the early work, however. Certain substances, tuberculocidal or tuberculostatic in character, have been shown to have the power of penetrating the tubercle *in vivo*. It has not been shown, on the other hand, that any substances congregate selectively in tuberculous tissue or that their concentration in this tissue will remain at a high level while falling in the blood. All that can be truly said is that access to the desired site of action of the drug is apparently possible to some substances, although the action of these substances *in vitro* may not be reproduced in the tubercle in the living animal.

In a general way one can postulate the properties which one would expect an effective chemical agent against tuberculosis to possess. It should have the ability (1) to inhibit the tubercle bacillus *in vitro* in high dilution, which presumably implies permeating to some extent at least the bacillary membrane, (2) to circulate freely in the blood for a very long period without injury to the host, (3) to pass from the blood stream, where tubercle bacilli are not found, to tuberculous tissue, and (4) to penetrate finally the tubercle, which, although presumably a defensive line of the body, nevertheless serves as a protection for the bacilli also. It will be noticed that *in vitro* activity of the agent has been put as the first critical requirement. That has been done not in the belief that a substance active in the test tube will necessarily retain its activity in the animal, or that a substance inactive in the test tube and possibly insoluble in ordinary media will inevitably be inactive in the animal. The organic chemist, however, attempting to produce a chemotherapeutic agent for tuberculosis, must have a simple and moderately quick test at his disposal in order that he may know that he is working along lines that have a reasonable chance of achieving success. The evaluation of a substance in an animal (the guinea pig for choice) is expensive in time and in materials, and is out of the question for most investigators until a substance is produced which has been judged promising on other grounds.

Of the earlier attempts at the chemotherapy of tuberculosis, as for example metal therapy or the use of antiseptics, it is not possible to predict that they may not yet prove successful in a modified form. Since these substances are inactivated by the presence of blood, the odds appear, however, to be all against them. Neither would it be safe to predict that an antibiotic substance may not be found which, unlike streptomycin, would achieve a complete disinfection of the animal body. It is more heartening, nevertheless, for the investigator to design his attack on the bacillus on the basis of a theory which relates to a fundamental circumstance, for example, in the metabolic processes or chemical composition of the tubercle bacillus.

One fundamental approach to this problem was based on fatty acids with branched-chains. The interest in this type of compound derives from two unrelated discoveries. The first of these was the final elucidation by Adams and his colleagues of the structure of chaulmoogric and hydnocarpic acids. These acids are obtained from chaulmoogra oil, which has been used for centuries in the East for the treatment of leprosy, and the leprosy bacillus is, of course, related to the tubercle bacillus.



Chaulmoogric acid $x = 12$; Hydnocarpic acid, $x = 10$.

The second of the discoveries to which I have referred was the isolation by Anderson and his co-workers of a number of liquid saturated acids from the lipoid fraction of the tubercle and other acid-fast bacilli[1]. Two of these acids were thoroughly examined and were shown to be unique at the time among naturally occurring fatty acids, in that they possessed a branched-chain, and one of them—tuberculostearic acid—an odd number of carbon atoms

$$CH_3—[CH_2]_7—CH(CH_3)—[CH_2]_8—COOH$$

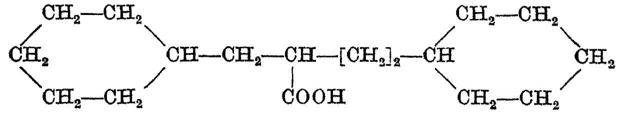
10-Methyl stearic acid (tuberculostearic acid).

The second acid, phthioic acid, has been the subject of synthetical studies by Robinson and his co-workers[2]. They at first considered it to be ethyl decyl dodecyl acetic acid, a substance which has very striking biological properties producing, on animal injection, cell reactions and tubercle formation very much like phthioic acid itself. As a result of further work, Robinson[3] has returned to the original views in a modified form of the American workers. It is now believed to be 3 : 13 : 19-trimethyl tricosanoic acid, which has been synthesised in an inactive form.

$$CH_3—[CH_2]_3—\underset{\displaystyle CH_3}{\underset{|}{CH}}—[CH_2]_5—\underset{\displaystyle CH_3}{\underset{|}{CH}}—[CH_2]_9—\underset{\displaystyle CH_3}{\underset{|}{CH}}—CH_2—COOH$$

Phthioic acid.

A very large number of acids, mostly of the di-substituted acetic acid type, was synthesized in Adams's laboratory and tested against various Mycobacteria[4]. It was shown that the cyclopentenyl ring in chaulmoogric acid fulfilled the function of a branched-chain. ω-Cyclohexyl aliphatic acids had maximum activity when the molecule contained 14–17 carbon atoms. Greater activity was found when the carboxyl group was in or near the centre of the molecule. The most effective of these acids against the tubercle bacillus *in vitro* was:



Inhibitory dilution, 1/50,000 *v. Myco. tuberculosis*.

In further synthesis, the ring structure was dispensed with and dialkyl acetic acids were prepared, which were most active when the —COOH was near the centre of the chain and when the molecule contained in all 15–17 carbon atoms. A molecule smaller or larger than this had a reduced biological activity.

$$CH_3—[CH_2]_x—\underset{\displaystyle COOH}{\underset{|}{CH}}—[CH_2]_y—CH_3 \qquad x + y = 11 \text{ to } 13$$

Our own synthetical approach started with roccellic acid (α-methyl-α'-n-dodecyl succinic acid), which was isolated from the lichen, *Lecanora sordida*. We have already reported[5] that this substance, in the form of its half-esters or half-amides, inhibits completely the growth of the tubercle bacillus *in vitro* at a dilution of about 1/500,000. From an examination of a series of dialkyl succinic acids, it is now clear that in the form of their half-esters, maximum inhibitory activity is encountered when the total chain-length of the alkyl substituents ranges from 13 to 15 carbon atoms. We have since synthesized a series of monoalkyl (C_8–C_{18}) succinic acids

$$\begin{array}{l} R'\text{—CH—COOEt} \\ \quad\ | \\ R''\text{—CH—COOH} \end{array} \qquad \begin{array}{l} R'''\text{—CH—COOH} \\ \qquad\ \ | \\ \qquad \text{CH}_2\text{—COOEt} \end{array}$$

and shown that the same pattern repeats itself, maximum biological activity being encountered when the alkyl group contains 13–15 carbons[6]. From the point of view of *in vitro* activity, therefore, dialkyl succinic acids have no advantage over monoalkyl acids. It is remarkable, however, that the half-ester

$$\begin{array}{l} \text{C}_7\text{H}_{15}\text{—CH}_2\text{—CH—C}_7\text{H}_{15} \\ \qquad\qquad\qquad | \\ \qquad\qquad\ \ \text{COOH} \end{array}$$

$$\begin{array}{l} \text{C}_7\text{H}_{15}\text{—CH——CH—C}_7\text{H}_{15} \\ \qquad\quad\ \ |\qquad\quad | \\ \qquad\ \ \text{COOEt COOH} \end{array}$$

of α-α'-di-n-heptyl succinic acid, which differs from heptyl octyl acetic acid only in the possession of an extra carbethoxy group, should be ten times as inhibitory as the latter of the growth of the tubercle bacillus *in vitro*. The most active of these compounds are at the moment being tested in animal protection experiments, and although they are strongly antagonized by serum *in vitro*, they seem to have some activity in the animal.

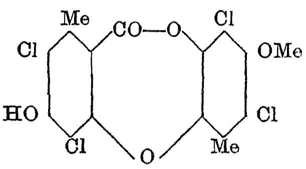
The comparative success which derivatives of diamino-diphenyl sulphone have met with in experimental tuberculosis in guinea pigs[7] suggested the synthesis of a new series of compounds which would contain a sulphone group, while yet retaining to some extent the essential structure of the succinic acid derivatives.

$$\begin{array}{l} R\text{—S—CH—COOH} \\ \qquad\ \ | \\ \qquad \text{CH}_2\text{—COOH} \end{array} \qquad \begin{array}{l} R\text{—SO}_2\text{—CH—COOH} \\ \qquad\qquad | \\ \qquad\quad\ \text{CH}_2\text{—COOH} \end{array}$$

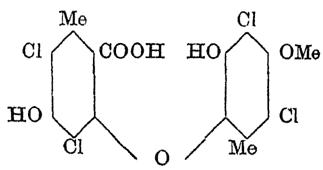
$$R = \text{C}_{11} \text{ to } \text{C}_{18}$$

These alkyl thiomalic acids and alkane sulphonyl succinic acids in the form of their half-esters are strongly inhibitory of the growth *in vitro* of *Myco. tuberculosis*. A curious feature of them, as investigated so far, is that they display no sharp peak of activity against mycobacteria, as the chain-length of R is increased. From $R = C_{11}$ to C_{18} the inhibitory dilution of both series of compounds remains more or less constant. This may be related to another peculiar feature which they possess. The alkylthiomalic acids ($R = C_9$ to C_{18}) all melt over a very narrow range of temperature (103° to 107° C.), and the alkane sulphonyl succinic acids which melt about 40° higher all melt also over a very narrow range (142°–147°). They are antagonized by serum *in vitro*. No results of animal tests are yet to hand.

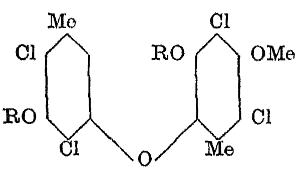
Compounds of a completely different type are also being investigated in this laboratory. As already reported[8], diploicin when rendered soluble in aqueous media by a slight alteration in its molecule completely inhibits the growth of the tubercle bacillus *in vitro* at a dilution of 1/100,000, and the diphtheria bacillus at 1/70,000. The carboxyl derivative A is easily soluble in neutral solution, but readily loses carbon dioxide to form B. Both A and B are active *in vitro*, but B is too insoluble for animal injection. C, D and E are modifications of the molecule made with the view of increasing solubility while preserving antibacterial power. The —COOH in D is stabilized by methylation of the hydroxyl in the *para*-position, but its activity is reduced very considerably. It was hoped that in E, solubility would be restored by hydroxyethylation while at the same time conserving the stability of the —COOH group. This compound, however, has very poor antitubercular power. C is also quite inactive, and it seems probable that a free phenolic hydroxyl group is necessary in each ring. The balance is clearly a delicate one, and the minimum clothing necessary for a halogenated diphenyl ether to have antitubercular properties will need to be arrived at from the synthetic end.



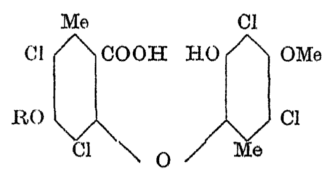
Diploicin



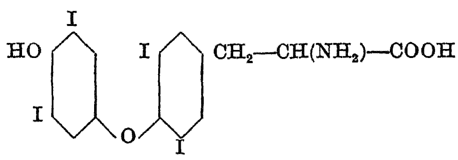
A. Active



B. (R = H) Active
C (R = —CH_2.COOH) Inactive



D (R = CH_3) Reduced activity
E. (R = —C_2H_4OH) Inactive



Thyroxine

The only known substance of the halogenated phenyl ether type, occurring normally in the animal body, is thyroxine, and its resemblance to diploicin suggested to the author that hyperactivity of the thyroid gland, resulting in excessive secretion of thyroxine, might provide a defence against the spread of tubercular infection in the animal body. Since this hypothesis was published[8], a report has appeared in the literature from Izzo and Cicardo[9], claiming that injection of thyroxine into guinea pigs infected with tuberculosis has produced a considerable prolongation of life over untreated animals, and that thyroidectomized guinea pigs show a very much reduced resistance to tuberculosis. It is not suggested that treatment with thyroxine is ever likely to be used as a protection against or cure for tuberculosis. Further work in this direction may, however, yield pointers of value to workers on the chemotherapy of tuberculosis.

[1] Anderson and Chargaff, *J. Biol. Chem.*, **85**, 77 83, 169 (1929)
[2] Robinson and Birch, *J Chem. Soc.*, 505 (1940).
[3] Polgar and Robinson, *J. Chem. Soc.*, 389 (1945).
[4] Adams *et al.*, *J. Pharm and Exp. Ther*, **45**, 121 (1932).
[5] Barry and McNally, *Nature*, **156**, 48 (1945).
[6] Barry and Twomey, *Proc. Roy. Irish Acad*, in the press
[7] Feldman, Mann and Hinshaw, *Amer. Rev Tub*, **46**, 187 (1942)
[8] Barry, *Nature*, **158**, 131 (1946).
[9] Izzo and Cicardo, *Nature*, **158**, 590 (1946).

OBITUARIES

Prof. E. H. Lamb

ERNEST HORACE LAMB was born at Adelaide on May 5, 1878. He left Australia for Great Britain when his father, the distinguished mathematician, Horace Lamb, was appointed to a chair at Owens College, Manchester. After attending Manchester Grammar School, Ernest had a distinguished career at Owens College (now Victoria University of Manchester). He gained his practical experience with Mather & Platt, Ltd., Manchester, and was afterwards employed by W. H. Allen, Sons & Co., Ltd., Bedford. In 1913 he was appointed professor of civil and mechanical engineering at East London College (now Queen Mary College), University of London.

Lamb served with distinction during the First World War, first with the Royal Marines and later with the R.N.V.R. After service throughout the Gallipoli campaign, when he was awarded the Distinguished Service Cross, he went to H.M.S. *Vernon*, at Portsmouth, where during 1917–19 he was in charge of experimental work and special designs for naval mining appliances.

When Lamb returned to Queen Mary College after the War, he played an active part in the development of the engineering studies of the College, and of the University of London. He was dean of the Faculty of Engineering of the University during 1924–28, and a member of the Senate of the University during 1929–34. He was dean of the College Faculty of Engineering, served on the governing body, and was appointed vice-principal of the College.

Ernest Lamb inherited his father's mathematical ability, and contributed papers on various engineering subjects to the engineering institutions and to the technical Press. He was a member of the Institution of Mechanical Engineers; and an associate member of the Institution of Civil Engineers, of which he was awarded the Telford Gold Medal.

With all his gifts and extraordinary ability, Lamb was devoid of any personal ambition. To all his many duties he brought a freshness of outlook, a capacity for work, and a sense of humour that endeared him to all his colleagues. He gave freely to help all around him, but preferred to remain himself in the background. For this reason his work, both scientific and administrative, was not so well known as it deserved to be, and it was only those who knew him best who appreciated just how much he contributed to the welfare of Queen Mary College.

At the outbreak of war in 1939, the College was moved to Cambridge, and, although Prof. Lamb reached retiring age in 1943, he carried on until the end of the War. He retired in 1945, being later appointed professor emeritus. He continued to live in Cambridge, where his many friends hoped he would be active for many years. He was looking forward to carrying on with work for which his College duties had not given time.

His many friends were shocked to learn that Prof. Lamb died suddenly of heart failure on October 12.

E. GIFFEN

Prof. A. E. Tchitchibabin

ALEXEJ EUGUENIEVITSCH TCHITCHIBABIN, born at Kuseminо, Poltava, in 1871, recently died in Paris at the age of seventy-four. He studied at the University of Moscow from 1888 for four years, and published his first scientific paper during that period. His work was on pyridine and its derivatives, a field then neither well known nor very popular; but in spite of opposition, he persisted with it and never lost interest in the field.

In 1902, he was made 'Magister Chimia' in the University of Moscow as a result of a thesis on the action of alkyl halides on pyridine and quinoline, and afterwards gained the rare honour of doctor of chemistry of the University of St. Petersburg; six years later he was appointed professor of organic chemistry at the Imperial College of Technology (Moscow), becoming dean of the College in 1909. In 1918 he was in addition professor of chemistry in the University of Moscow. During the First World War, Tchitchibabin undertook the organisation of the Russian pharmaceutical industry and, largely due to his work, his country became substantially independent of German supplies. In 1931, Tchitchibabin moved to Paris and directed the laboratory of the Collège de France.

Most of Tchitchibabin's two hundred or so publications are concerned with pyridine and its derivatives; among other things he synthesized pyridine itself from acrolein and acetaldehyde, an example of a general method for synthesis of pyridine derivatives due to his researches, and found that acrolein could be substituted for glycerol in the Skraup quinoline synthesis. In 1913, with his co-worker Seide, he made one of those rare discoveries in chemistry—an entirely new reaction by which 2- and 4-aminopyridines could be obtained by the action of sodamide on pyridine. This reaction, he showed, takes place in two stages, the intermediate sodamidopyridine being decomposed by water. This remarkable discovery was not at first appreciated by chemists outside Russia, due possibly to the fact that it was published in Russian; but, as is shown later, had very important industrial and academic implications in due course.

Tchitchibabin and Seide also showed that alkyl halides could be induced to react with α- and γ-picolines in the presence of sodamide to give higher alkylated pyridines.

Tchitchibabin and his assistants also studied the tautomerism of the aminopyridines, in particular of 2-aminopyridine, which like 4-aminopyridine and unlike 3-aminopyridine is not a true amino compound, and which cannot be diazotized and coupled to give azo dyestuffs.

2-Aminopyridine has been manufactured in large quantities by Tchitchibabin and Seide's method in connexion with the manufacture of sulphapyridine (M and B 693); condensed with *p*-acetamidobenzene-sulphonyl chloride, the acetyl derivative of this sulphonamide is obtained from which the drug itself can be prepared by alkaline hydrolysis.

As a result of the work on sulphapyridine, 2-aminopyridine has now become available in large quantities as an intermediate with a large potential value in the laboratory and in industry.

In 1924, Tchitchibabin published his work, "Fundamental Principles of Organic Chemistry" (translated into French); this work is dedicated to his only child, his daughter Natacha, who was tragically killed in an accident in a chemical factory. Tchitchibabin's wife, Vera Vladmirovna, was also a scientific worker.

M. A. PHILLIPS

WE regret to announce the following deaths:

Dr. Harry Roberts, well known as a writer on social medicine and related topics, on November 12, aged seventy-five.

Prof. F. M. Rowe, F.R.S., professor of colour chemistry and dyeing in the University of Leeds, on December 8, aged fifty-five.

Mr. J. D. Watson, formerly engineer to the Birmingham, Tame and Rea Drainage Board, and a past-president of the Institution of Civil Engineers, on November 23, aged eighty-six.

NEWS and VIEWS

Plumian Chair in the University of Cambridge
Prof. H. Jeffreys, F.R.S.

PROF. HAROLD JEFFREYS, who has recently been elected to the Plumian professorship of astronomy and experimental philosophy in the University of Cambridge, in succession to the late Sir Arthur Eddington, is a theoretical geophysicist of world-wide repute. He has been a fellow of St John's College, Cambridge, since 1914, and a fellow of the Royal Society since 1925. During the First World War, and for several years afterwards, he was at the Meteorological Office, and following a period of some years as a lecturer at his own College he was appointed reader in geophysics in the University of Cambridge in 1931. He is perhaps best known as a seismologist, but as evidence of his versatility it may be mentioned that, in addition to gaining the Adams Prize in 1927, he has been awarded the Buchan Prize by the Royal Meteorological Society (1929), the Gold Medal of the Royal Astronomical Society (1937) and the Murchison Medal of the Geological Society (1939). He has written extensively on probability, notably in relation to significance tests, and an axiomatic exposition of the theory is set out in his book on the "Theory of Probability", to which his earlier book, "Scientific Inference", makes a suitable introduction. His books on Cartesian tensors and on operational methods have been a stimulus to the use of these techniques. The best-known work of Prof. Jeffreys is undoubtedly "The Earth", and it may fairly be said that this treatise, much of it his own researches, welded together a number of scattered topics into a coherent subject. It was indeed felicitous that he dedicated this work in 1924 to a former Plumian professor, Sir George Howard Darwin, "The Founder of Modern Geophysics".

Crystallography at University College, London
Dr. Kathleen Lonsdale, F.R.S.

A READERSHIP in crystallography has been established in association with the Department of Chemistry of University College, London, and Dr. Kathleen Lonsdale has been appointed to the post. This marks the first major step in the creation of a new university centre for the training of crystallographers and crystallographic research workers. Dr. Lonsdale, who received her university education at Bedford College, London, distinguishing herself in physics and mathematics, obtained her research training at the Royal Institution under the late Sir William Bragg, whose research assistant she eventually became. Except for two years as Amy Lady Tate Fellow in the University of Leeds, and for short periods covering the infancy of her children, Dr. Lonsdale has, since graduation, been associated with the Royal Institution, latterly as Dewar Fellow, and during the past twenty years as one of the most notable contributors to its distinguished record of research. She was one of the first two women to be elected to the fellowship of the Royal Society.

Dr. Lonsdale has taken a leading part in the development of modern experimental and mathematical methods in the X-ray analysis of crystals. She pioneered the determination of molecular structure by Fourier analysis of X-ray patterns, and was the first to establish the size and shape of the benzene ring in hexamethyl benzene and hexachlorobenzene. She took a leading part in the establishment of magnetic anisotropy and its molecular significance in aromatic crystals. She has shown how the thermal vibrations, and hence the elastic forces, in crystals can be investigated by means of the diffuse X-ray reflexions, which had not been previously understood. She has recently been developing the divergent beam method of X-ray analysis, and the study of crystal texture by that method.

Dr. Frans Verdoorn

THE first Mary Soper Pope Medal of the Cranbrook Institute of Science, Michigan, has been awarded to Dr. Frans Verdoorn, editor of *Chronica Botanica*, in recognition of his editorial and international relations work in biology as well as for his researches in cryptogamic botany and the history of the plant sciences. Dr. Verdoorn, who was born in Amsterdam in 1906, went to the United States in 1940. He is managing editor of the Chronica Botanica Co., which publishes *Chronica Botanica*, "A New Series of Plant Science Books", and *Annales Cryptogamici et Phytopathologici*. He is also botanical secretary of the International Union of Biological Sciences and special adviser to the Netherlands Indies Department of Agriculture. His principal books are: "de Frullaniaceis" X–XVIII, "Manual of Bryology", "Manual of Pteridology", "Plants and Plant Science in Latin America", "Science and Scientists in the Netherlands Indies" (with P. Honig), and the "Index Botanicorum", a biographical dictionary of plant scientists, now in preparation in co-operation with the Arnold Arboretum of Harvard University, with which Dr. Verdoorn has been connected since 1941. From 1947 onwards, Dr. Verdoorn will issue a monthly biological news-letter, *Biologia*, and an annual review of progress in international relations and co-operation in science, to be entitled *Pallas*.

Scientific Appointments at the Ministry of Supply

SIR BEN LOCKSPEISER, director-general of scientific research (air) at the Ministry of Supply, has been appointed chief scientist to the Ministry. This newly created post is a continuation of the co-ordination of the research and development programmes for defence and air resulting from the merger earlier this year of the Ministry of Supply and the Ministry of Aircraft Production. Sir Ben will be responsible in future for co-ordinating research work on the Ministry's military and aeronautical programmes, and for supervising the general interests and welfare of its large scientific staff. He will be assisted in these duties by the Scientific Co-ordinating Board, to which Sir John Lennard-Jones has agreed to continue to act as chairman for the present. The Ministry has also announced that the following four appointments, all at Principal Director level, will be incorporated in its higher organisation for research and development: *Scientific Research (Air)*: Mr. H. M. Garner, who has held a number of posts in the scientific departments of the Air Ministry, Ministry of Aircraft Production and Ministry of Supply since his entry into Government service soon after the First World War; between 1942 and 1945 he was deputy director of scientific research in the Ministry of Aircraft Production. *Technical Development (Defence)*: Mr. T. R. B. Sanders, who served with the Royal Artillery in the early part of the War, later becoming assistant chief engineer of armaments design in the Ministry of Supply. *Scientific Research (Defence)*: Dr. E. T. Paris, who joined the Ministry of Supply upon its formation in 1939, previously having been deputy director of scientific research at the War Office; prior to taking up his present appointment he was controller of physical and signal development in the Ministry of Supply, being responsible (under the Director-General of Scientific Research and Development) for all Army signals and radar development. *Technical Development (Air)*: Mr. S. Scott-Hall, who from 1944 until taking up his present post was superintendent of performance testing at the Aeroplane and Armaments Experimental Establishment, Boscombe Down, Wiltshire; between 1941 and 1944 he was head of the Armament Research and Development Department of the Royal Aircraft Establishment, Farnborough.

The Ministry of Supply further announces that responsibility for all branches of research and development concerning guided projectiles—including the proposed range in Australia—are to be integrated under the Controller of Supplies (Air). Details of the new organisation will be given in due course.

National Coal Board: Director of Carbonization Research

THE National Coal Board announces that Prof. H. L. Riley, professor of inorganic and physical chemistry in the University of Durham, has been appointed director of carbonization research under the scientific member of the Board, Sir Charles Ellis. Prof. Riley studied at the Imperial College of Science and Technology, and took an honours degree in inorganic chemistry; he was awarded the Frank Haddon Prize. He held a Beit Research Fellowship during 1921–23, and remained as lecturer at the Imperial College until he went in 1932 to King's College, University of Durham. Prof. Riley's research work at Newcastle has been devoted to the study of coking problems, and he is recognized as an expert in this field. He is also honorary secretary and director of research to the Northern Coke Research Committee, and is a member of the British Coking Research Association. He is forty-seven years of age.

Chemistry at Chelsea Polytechnic: Dr. J. F. J. Dippy

WHEN Dr. C. Doree retired from the post of head of the Department of Chemistry at the Chelsea Polytechnic in 1940, the vacancy was filled by the promotion of Dr. J. C. Crocker, then first assistant in the Department; Dr. Crocker retired at the end of August. Dr. John F. J. Dippy has now been appointed to the post. Educated at University College, Swansea, Dr. Dippy showed early promise as a research worker, and his work has been well recognized in Great Britain and in the United States. He is an energetic man with interests in both pure and applied chemistry. Beginning with a lectureship in chemistry at the Cardiff Technical College (1930), Dr. Dippy moved to a headship at the Mining and Technical College, Wigan (1942), and is at present head of the Department of Chemistry and Biology at the South-East Essex Technical College, Dagenham (since 1945). He has high academic and administrative ability.

Agricultural Attaché at the British Embassy in Buenos Ayres

MAJOR T. A. RATTRAY has been appointed agricultural attaché to the British Embassy in Buenos Ayres. Major Rattray, who is fifty-seven, was educated at Winchester. After service in the First World War, he farmed in Shropshire and Somerset until, in 1934, he took up an appointment with the Ministry of Agriculture as a livestock officer. From 1939 onwards Major Rattray has acted as one of the Ministry's land commissioners.

Reports on German Industrial and Scientific Progress

IN a written answer to a question regarding reports on German industrial and scientific progress on December 5, the President of the Board of Trade stated that 1,390 such reports have been published to date, 572 by British teams, 278 by American teams and 540 by combined teams, and it is expected that the total would approach 2,500. In addition to placing the reports on sale at H.M. Stationery Office, free distributions of all reports published are made to universities, the principal public libraries and chambers of commerce. Trade and research associations and learned professional institutions also receive a token free distribution of the reports of direct interest to them. Arrangements have been made with the Stationery Office to produce both a classified list of the reports and a subject index, and an Information Bureau and Reference Library has also been created at the secretariat of the British Intelligence Objectives Sub-Committee, which body is now administered by the Board of Trade. This Reference Library contains not only all the finished reports but also much of the raw material on which they were based. The work is closely co-ordinated with the Documents Unit of the Board of Trade, which is the central repository for the large quantity of original German documents collected in the British and allied investigations. The Unit has facilities for translating and abstracting and for supplying copies of the abstracts or of the original documents to any interested party, and this Information Service, with a nucleus technical staff and access both to the reports and to the original German documents, should be of great assistance to firms with limited research facilities. Publicity is being given to this service and facilities by an exhibition opened at the Board of Trade at Millbank, London, on December 10; the exhibition will eventually be shown in the most important provincial industrial centres of Britain.

Centenary of the Sewing Machine

SEWING needles of bone date back to prehistoric times, and the steel needle made its first appearance in Britain in the sixteenth century. The speed of expert hand-sewing, thirty stitches per minute, is slow and laborious compared with that of machine work, and with the ushering in of the mechanical age in the eighteenth and nineteenth centuries, it is not surprising that the invention and development of the sewing machine should have come about early in this period. A chain-stitch machine with its single thread had already been made by B. Thimmonier, in 1830, and a machine produced by W. Hunt, in 1832–34, had an eye-pointed needle and an oscillating shuttle. It remained for Elias Howe to make and patent, in 1845, the first successful lock-stitch machine, in which an eye-pointed needle and an independent shuttle, each with its own thread, were used. He disposed of his English interests in the patent to William Frederick Thomas, of Cheapside, in whose name the British patent stands, dated December 1, 1846. The Royal Scottish Museum, Edinburgh, is commemorating the occasion of the centenary by holding a small exhibition of sewing machines. Thanks to the generosity of Mr. A. W. Pickard, of Glasgow, the Museum has in its collection one of the first six of the 1846-type machines, which were made by Howe. A number of other machines of dates ranging over the complete century of development are shown. These include early Howe and also Wheeler and Wilson machines, while modern development is illustrated by the latest domestic and workroom models of the Singer Sewing Machine Co.

University of Birmingham

THE pro-chancellor of the University of Birmingham, Mr. Edmund P. Beale, is retiring after having held office since 1939. Mr. Beale, whose father was the first vice-chancellor of the University, became a member of the University Council in 1924 and was treasurer from 1930 until 1939. To commemorate his services, Mr. Beale has been presented with a portrait of himself, painted by Mr. A. Middleton Todd. The chancellor of the University, Mr. Anthony Eden, who made the presentation on behalf of the subscribers, paid a warm tribute to the work done by Mr. and Mrs. Beale for the University. The success of the recent appeal for funds, in response to which more than £1,000,000 has already been subscribed towards the £1,500,000 asked for, owes much to Mr. Beale's personal efforts. The vice-chancellor, Dr. Raymond Priestley, said that when he came to Birmingham he was somewhat prejudiced both against a lay element in a university council and lay honorary officers; but he now believes it to be the best possible system for a university like that of Birmingham. Mr. Beale, he said, typified integrity, loyalty and grit, and "one who can appreciate—as not all laymen do—academic standards and ideals. He has stood for a university of national and international standards both of teaching and research."

The newly formed Department of Chemical Engineering in the University of Birmingham is giving special attention to the problems of fuel technology and the utilization of coal. On the occasion of a recent visit of more than a hundred executives of the gas and allied industries, the vice-chancellor emphasized the importance of making the best possible use of our remaining supplies of coal and high-grade iron ore. "We must capitalize," Dr. Priestley said, "our best brains, our national skill, and the faculty for the co-ordination of hand and brain in which, as a people, we are endowed, I believe, beyond most others, and it is in these fields that this university plans to help."

Organisation for the Interchange of Technical Publications in Sheffield

A REPORT on the war-time work of the Organisation for the Interchange of Technical Publications in Sheffield was presented to the annual general meeting held in the Sheffield Central Library on November 5 This Organisation provides the framework for a system of co-operation between the Sheffield City Libraries, the University Library and other research libraries in the area, and the libraries maintained by local firms. Through its agency any member library, research workers employed by member firms, or accredited students at the constituent libraries, can draw on the pooled resources of the twenty-nine libraries included in the Organisation. Some of the member libraries are of such a highly specialized nature and cover so small a field (although in minute detail) that they rely largely on the extensive resources of the Science and Technology Department of the City Library in matters outside the range of their own material. Hence, as the largest contributor to the pool, the tasks of administering the scheme and of preparing research bibliographies on specific aspects of research (a service not, however, confined to members of the Organisation) fall on the City Libraries. The close collaboration between the highly specialized works libraries and research staffs and the City Library allows the latter to benefit from the advice of experts in the selection of books and in the preparation of its research publications. From the beginning of the War until November 1946, 8,163 books, periodicals, etc., were recorded as being interchanged by members, but the actual figures of loans were much higher.

At the annual general meeting, applications for membership from the Bragg Laboratory of the Admiralty, the Davy and United Engineering Company, Hall and Pickles, Ltd., Edward Pryor and Son, Ltd., and the Sheffield and District Gas Company were approved, bringing the total number to six society and twenty-three works members. It was also decided to investigate the possibility of obtaining research services in foreign patents through the Fédération Internationale de Documentation at The Hague. Resolutions were passed asking the Association of Special Libraries and Information Bureaux to urge the Patent Office to publish indexes and abridgments to British patent specifications of the war years, and to make representations to the appropriate Government department on the desirability of providing a national loan service of standards specifications from all countries.

Secondary Electron Photography

Two recent letters in the correspondence columns of *Nature* (Tasker and Towers, **156**, 695; 1945, and Roberts, **157**, 695; 1946) have brought to notice the work of Prof. J. J. Trillat and his colleagues at the Centre National de la Recherche Scientifique, on secondary electron photography. This work, carried out during the war years, is described in a series of notes in the *Comptes Rendus* and the *Revue Scientifique*, Paris, between 1941 and 1945; the fact that it was not referred to earlier is an example of the difficulty of consulting war-time foreign journals. Most of the experiments are concerned with the surface appearances of metal specimens. A low-speed photographic film is placed in contact with the metal surface and irradiated with X-rays of 150–200 kV. The direct effect of the X-rays on the film is small, but the secondary electrons emitted by the metal produce an image of the surface. Differential blackening is produced by metals of different atomic numbers, and with careful control the method is capable of qualitative analysis. Both macroscopic and microscopic photography are possible. For example, a reflexion electron photograph of a magnesium–aluminium alloy containing some manganese, under the microscope shows the distribution of the heavy element around the magnesium–aluminium crystals. This opens up an interesting field in surface metallurgy, with relatively simple apparatus. Alternatively, the secondary electrons from a thin sheet of lead may be used to 'radiograph' very thin objects such as paper or tissue sections. The results are similar to those obtained with very soft X-rays.

Agriculture and the Association of Scientific Workers

The annual conference of the Agricultural Section of the Association of Scientific Workers was held in London during November 23–24 and attended by delegates from all parts of Great Britain. The conference was addressed by Prof. J. A. Scott Watson, chief of the advisory service of the Ministry of Agriculture, on the technical advisory services in agriculture. There was a discussion on the future of British agriculture and the part that agricultural scientists could play in the research and advisory services. Dissatisfaction with the conditions of service was expressed by many members, and it was agreed that the efficiency of the food production programme might be seriously impaired unless far more adequate provision was made for science and scientific workers. The present critical labour situation in the industry was discussed in detail. A delegate from the National Union of Agricultural Workers stated that the shortage of labour has been greatly exaggerated, and that the introduction of foreign labour is in no way a permanent solution of this difficulty. Mechanization, improved wages and living conditions and an apprenticeship scheme would be of more value.

Many resolutions covering a wide field were discussed, including the need for improved co-ordination between universities and existing institutes for planning more fundamental agricultural research, and the provision of conditions to attract first-class men of science to this work. It was urged that provision should be made on the agricultural research planning boards for representation of the views of the ordinary scientific worker, and that agricultural scientists in general should be assimilated to the White Paper scales as appropriate to their age and service irrespective of their previous salaries. There was considerable discussion on the National Agricultural Advisory Service.

Naming the Constellations

Henry I. Christ has an interesting article with this title in *Sky and Telescope* of October, which describes a number of proposed names for the constellations which 'fell by the wayside'. Even those suggested to flatter or honour monarchs, such as Frederick's Glory, Charles' Oak, did not survive for very long, though Sobieski's Shield, in honour of the Polish hero who fought the Turks, has been retained. How many people realize the length of the list of forgotten constellations? These include such animals as a cat, a flamingo, a turtle, a reindeer, a night owl and a thrush, and even objects like a printing office, an electric machine, a balloon, a solarium, a sceptre, and a quadrant, some of which were retained for a time, while others never gained acceptance. Wholesale recharting of the sky has not been a success, and perhaps it is just as well that the artificially fostered systems did not last.

Commonwealth of Australia Council for Scientific and Industrial Research

The annual report of the Council for Scientific and Industrial Research, Commonwealth of Australia, has now been supplemented by a more concise and popular illustrated account (Melbourne: Gov. Printer). Written by Mr. G. Lightfoot, consultant, and former secretary to the Council, with a foreword by Mr. J. J. Dedman, the Minister in Charge, it gives a lucid account of the establishment and development of the Council and of the work carried out during 1945 by the various divisions, illustrating particularly the way in which scientific research can assist the further utilization of Australian resources and the development of its industries. The Council and the author are to be congratulated on the high standard of production and exposition in this brochure, which is admirably designed for the educational purposes it is intended to serve.

Meldola Medal

The award of the Meldola Medal, which is the gift of the Society of Maccabæans, has normally been made annually, but has been suspended since 1941. The award is to be resumed for 1946, and the Society of Maccabæans will accordingly present it to the chemist who, being a British subject and less than thirty years of age on December 31, 1946, shows the most promise, as indicated by his or her published chemical work. Recommendations and applications, to be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal", must be received before December 31, 1946.

Catalogue of Historical Scientific Books

Messrs. Davis and Orioli's latest Catalogue, No. 125, Classics of Science and Medicine, is a lavishly illustrated production containing 444 items. The field covered includes physics, chemistry, astronomy, mathematics, biology, medicine and surgery. Many outstanding works in all these branches of knowledge are offered for sale. Among the authors represented, often by several of their works, in first or early editions, are the following, selected more or less at random: Robert Boyle, Roger Bacon, Descartes, Galileo, William Gilbert, William Harvey, Hippocrates, Robert Hooke, James Hutton, Christian Huygens, Johannes de Ketham, Lavoisier, Sir Isaac Newton, Ambroise Paré, Pasteur, Scheele, and Vesalius. The prices asked, and presumably obtainable, are in many cases high; and are an indication of the marked trend in recent years for early scientific and medical works to appreciate in value. An interesting sidelight as to how the scarcity, as opposed to the absolute scientific importance, of a book may affect values is afforded by a comparison of the prices asked for James Hutton's "Theory of the Earth" (£175) on one hand, and Newton's "Principia" (1st edition, 2nd issue, £130) on the other. It has long been realized that copies of the former are extremely difficult to find, and also that it was an epoch-making work; yet it can scarcely be claimed that it ranks in importance with Newton's *magnum opus*.

Colonial Service Appointments

THE following appointments in the Colonial Service have been announced: A. L. Barcroft, to be agricultural officer, Malaya; P. A. Donovan, to be agricultural officer, Sierra Leone and Gambia; A. Hyslop, to be agricultural survey officer, Gold Coast; N. F. Robertson, to be plant pathologist, West Africa Cocoa Research, Gold Coast; P. F. Burgess, to be assistant conservator of forests, Malaya; W. E. S. Mutch, to be assistant conservator of forests, Nigeria; J. C. Wilson, to be assistant conservator of forests, Gold Coast; Major D. J. Gear, to be geologist, Uganda; Flt.-Lieut. E. G. Davey, to be assistant director, Observatory, Mauritius; Lieut. C. G. Dixon, to be senior geologist, British Guiana; R. Mather, to be meteorological officer, Malaya; T. Bell, agricultural superintendent, British Guiana, to be senior agricultural officer, Palestine; E. J. Shrubshall, senior assistant conservator of forests, Malaya, to be conservator of forests, Malaya; G. W. Somerville, senior assistant conservator of forests, Malaya, to be conservator of forests, Malaya.

Announcements

DR. JULIAN HUXLEY, executive secretary of the Preparatory Commission of the United Nations Educational, Scientific and Cultural Organisation, has been appointed director-general of the Organisation.

MR. J. M. COOK, sometime lecturer in classical archæology in the University of Edinburgh, has been appointed director of the British School of Archæology in Athens.

DR. ALEXANDER MULLER, of the Davy Faraday Research Laboratory of the Royal Institution, has been appointed deputy director of the Laboratory.

THE Pest Infestation Laboratory of the Department of Scientific and Industrial Research, originally set up at Slough, Bucks, in 1940, is to be extended. Mr. G. V. B. Herford, at present officer-in-charge, has been appointed director of the Laboratory.

THE Olaf Bloch Memorial Award was founded by the Institute of British Photographers and the Royal Photographic Society jointly in 1946 as a tribute to the memory of Olaf Bloch. The award, consisting of books to the value of about £10, will be given for an essay, the subject of which for 1947 is "The Effect of the Introduction of Panchromatic Emulsions on the Applications of Photography". Particulars can be obtained from the Secretary, Institute of British Photographers, 49 Gordon Square, London, W.C.1; the closing date for the competition is June 1, 1947.

THE Institution of Civil Engineers has arranged three Christmas lantern lectures for boys on "Railways: How They Are Built and How They Run", to be delivered by Mr. Cecil J. Allen (December 30), Mr. L. G. B. Rock (January 3) and Mr. O. S. Nock (January 6). Tickets are issued for each lecture, and can be obtained free of charge from the Secretary, Institution of Civil Engineers, Great George Street, Westminster, S.W.1. The lectures are primarily intended for boys between thirteen and seventeen years of age.

A COURSE of twelve lectures on "Recent Advances in Dairy Technology" is to be given at the Central Laboratories, Express Dairy Co. Ltd., under the auspices of Chelsea Polytechnic early in the New Year. The lectures will be given on Tuesdays at 6.30 p.m., beginning on January 14, and are intended to serve the interests not only of persons engaged in the control of milk in its preparation for the consumer but also of medical officers of health, public analysts, food chemists and others concerned with milk as a foodstuff and with public health. The fee for the course is £1; particulars are available from the Chelsea Polytechnic. An inaugural address, open to the public, will be given by Dr. N. C. Wright, director of the Hannah Dairy Research Institute, on January 7.

A SHORT course of about twelve lecture-demonstrations on television practice, commencing Thursday, January 16, at 7–9 p.m., have been arranged at the South East London Technical Institute, Lewisham Way, London, S.E.4. The fee for the course is £1. Particulars can be obtained from the head of the Electrical Engineering Department of the Institute.

THREE graduate memberships of the Royal Institution are to be awarded in 1947. Graduates of either sex, of any university of the British Empire, who have graduated during 1946 with first- or second-class honours in any scientific subject, are eligible. Forms of application can be obtained from the General Secretary, Royal Institution, 21 Albemarle Street, London, W.1, to whom they must be returned by January 15.

THE Council of the Institution of Metallurgists has made arrangements for the operation of an appointments register, commencing in January 1947, the purpose of which is to put in touch members of the Institution who are seeking posts and employers having vacancies on their metallurgical staffs. Inquiries should be addressed to the Registrar, Appointments Register, Institution of Metallurgists, 4 Grosvenor Gardens, London, S.W.1.

IN the note entitled "Documentation in Switzerland" in *Nature* of November 23, p. 742, it was stated incorrectly that the publication under notice was by T. van Schelven and published by the Kosmos Publishing Co. of Amsterdam. The pamphlet is issued by the Schweizerische Vereinigung für Dokumentation from the library of the Technical High-School, Zurich.

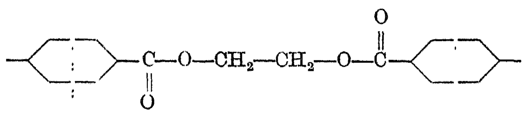
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Structure of Terylene

THE recent joint announcement by the Calico Printers' Association and Imperial Chemical Industries, Ltd., of the discovery of a new fibre-forming polymer permits the publication of the following short account of an X-ray investigation carried out on this material in the summer of 1944. The fibres, now known to be terylene, were prepared by Dr. D. V. N. Hardy at the Chemical Research Laboratory, Department of Scientific and Industrial Research, Teddington, and they had been submitted for other examination.

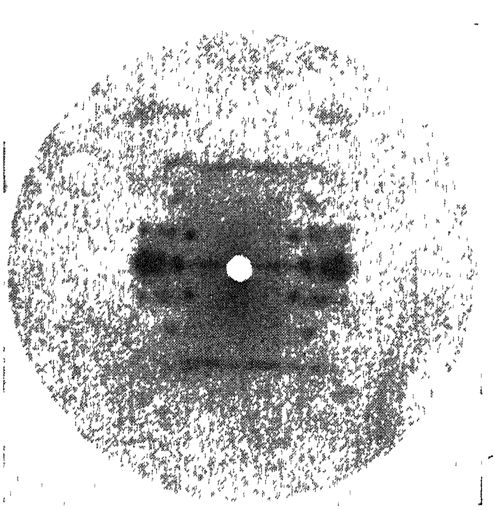
Polyethyleno terephthalate (terylene) gives a well-oriented X-ray fibre diagram, and some forty spots have been indexed unequivocally on the basis of a one-molecule triclinic unit cell. The dimensions of this unit cell, taking [c] as the fibre axis, are [a] = $5{\cdot}5_4$ A. ; [b] = $4{\cdot}1_4$ A. ; [c] = $10{\cdot}8_6$ A. ; $\alpha = 107°_{5'}$; $\beta = 112°_{24'}$; $\gamma = 92°_{23'}$. The repeating unit of terylene :



may possess a centre of symmetry, and the space group is probably $P\bar{1}$. The theoretical density required by the above unit cell is 1·47 gm./c.c., but the experimental determination is rendered somewhat uncertain by swelling, etc. Average values of 1·41 gm./c.c. have, however, been obtained by flotation in sodium iodide solutions.

Taking the bond-lengths C–C = 1·54 A., C–O = 1·42 A., C(ring)–C(aliphatic) = 1·48 A., and standard angles, the calculated period along the fibre axis comes to 10·9 A., in agreement with the value [c] = $10{\cdot}8_6$ A. given by the X-ray photographs.

In the usual way, X-ray fibre photographs reveal increasing disorientation simply by a drawing-out of the spots into arcs, but terylene is peculiar in that poorly oriented preparations give photographs like those produced by a single crystal rotating about an axis inclined at a small angle to a principal axis ; the spots are displaced to varying extents out of the true layer-lines, and in particular the intense $1\bar{1}0$ reflexion is seen as two overlapping spots, one just above and the other just below the equator. This means that in the drawing process it is somehow more difficult to pull the ($1\bar{1}0$) planes into parallelism with the fibre axis. The spacing of these planes is 3·38 A., and their intensity is far the strongest in the photograph, which suggests that the terylene chains are approximately flat and lie in the ($1\bar{1}0$) planes. Presumably then, on drawing out a fibre, the chains or groups of chains are first pulled straight by slipping parallel to the ($1\bar{1}0$) planes, and afterwards, with more difficulty, these planes themselves are pulled into parallelism.



X-RAY FIBRE PHOTOGRAPH OF TERYLENE, SHOWING CENTRAL PORTION ONLY. THE FIRST THREE SPOTS FROM THE CENTRE ALONG THE EQUATOR ARE 100, 010 AND $1\bar{1}0$

A three-dimensional model, in which the oxygen atoms in neighbouring chains are found to approach to approximately 3·1 A., has been constructed in accordance with the above scheme, and the X-ray intensities calculated from it are in good agreement with those observed. The full details will be published elsewhere.

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C. J. BROWN

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Nov. 18.

Determination of the Upper Limits of the Fission Cross-sections of Lead and Bismuth for Li-D Neutrons by a Chemical Method

THEORETICALLY, fission of elements of atomic number 83 and less is not excluded. The fission thresholds for the compound nuclei formed in neutron capture by lead and bismuth have been estimated as 9·3 MeV. for Bi^{210}, 10·0 for Pb^{207}, 10·4 for Pb^{208} and 10·7 for Pb^{209} [1]. If the neutron-binding energy is 5·4 MeV. for initial nuclei with an even, and 6·4 MeV. with an odd, number of neutrons, 3·9, 4·6, 4·0 and 5·3 MeV. have to be supplied as kinetic neutron energy to Bi^{209}, Pb^{206}, Pb^{207} and Pb^{208} to reach the presumed fission thresholds. We have searched for the fission of lead and bismuth with fast neutrons from the Li-D reaction by looking for any radio-iodine formed. In chemical methods for the measurement of fission-rates, very much larger amounts of material can be used than in fission chambers. On the other hand, chemical methods in a hypothetical process are based on the admittedly uncertain assumption that the element selected would appear as a fission product. We have chosen iodine as it is in the middle of one of the groups of fission products from uranium, and several of its isotopes are produced abundantly with this element. The ease of extraction of iodine was the reason why Libby[2] used it in an experiment to set a limit to the spontaneous fission-rate in uranium.

In separate runs, 7 kgm. lead oxide and 4·5 kgm. bismuth oxide were irradiated for $6\frac{1}{2}$ hours in a tin fitting closely the lithium hydroxide target tube of the Cambridge High Tension set. The current of 900 keV. deuterons was 50 μ amp. After irradiation, the material was dissolved with stirring in nitric acid under a toluene layer containing 500 (lead run) or

700 (bismuth run) mgm. iodine. The aqueous layer was removed in a separating funnel, the toluene washed with dilute acid and water, and iodine extracted from the toluene with sulphur dioxide solution. To the iodide solution so produced excess copper sulphate was added, the precipitated copper iodide filtered, washed with sulphur dioxide solution, water and acetone and tested with a mica window Geiger–Müller counter. Uranium (that is, U^{238}) was used as a monitor. Uranium nitrate ($UO_2(NO_3)_2 \cdot 6H_2O$)—34 gm. in the lead run, 20 gm. in the bismuth run—was embedded in the bulk material in a tube at a representative distance, and after irradiation worked up in the standard way with 500 or 200 mgm. iodine carrier. Naturally, here the yield of copper iodide was higher, as there was less opportunity for chemical or handling losses.

The ratio of the cross-sections is given by

$$\frac{\sigma}{\sigma_{U^{238}}} = \frac{A}{A_U}\,\frac{W_U}{W}\,\frac{M}{M_U}\,\frac{P}{P_U}\,\frac{Y_U}{Y}\,f,$$

where A are the measured activities, W the weights (of the elements) irradiated, M the atomic weights, P the weights of the iodine carrier used, Y the weights of the copper iodide recovered, and f an estimated factor to account for the difference in the self-absorptions. After deduction of the background (26 counts/min.), the copper iodide (41·5 mgm.) from lead gave 3 ± 1, and the copper iodide (228 mgm.) from uranium 2,190 counts/min. 90 min. after irradiation. In the bismuth run, the figures were $-1{\cdot}5 \pm 1{\cdot}5$ (21 mgm. copper iodide) and 1,605 (206 mgm.) 75 min. after irradiation. If we accept as an upper limit of the activity of the sample the difference against the background plus three times the probable error, we get

$$\frac{\sigma_{Pb}}{\sigma_{U^{238}}} < \frac{6\times(34\times0{\cdot}474)\times207\times0{\cdot}5\times0{\cdot}228}{2190\times(7000\times0{\cdot}928)\times238\times0{\cdot}5\times0{\cdot}0415}\,0{\cdot}40 < 1{\cdot}3\times10^{-5}$$

$$\frac{\sigma_{Bi}}{\sigma_{U^{238}}} < \frac{3\times(20\times0{\cdot}474)\times209\times0{\cdot}7\times0{\cdot}206}{1605\times(4500\times0{\cdot}897)\times238\times0{\cdot}2\times0{\cdot}021}\,0{\cdot}38 < 5{\cdot}0\times10^{-5}.$$

These figures refer to the whole Li-D spectrum, and in the case of lead to the natural isotopic mixture. The cross-sections referring to individual isotopes and to neutrons above the calculated thresholds are more significant. The abundances of the main isotopes of lead are 0·236, 0·226 and 0·523, and the abundances of the 'effective' neutrons can be derived from the data by Richards[3] as 0·63, 0·67 and 0·58 for Pb^{206}, Pb^{207}, Pb^{208}, and 0·68 for bismuth. Practically all Li-D neutrons are effective in the fission of U^{238}. Then,

$$\frac{\sigma_{Pb^{206}}}{\sigma_{U^{238}}} < 9 \times 10^{-5} \qquad \frac{\sigma_{Pb^{207}}}{\sigma_{U^{238}}} < 9 \times 10^{-5}$$

$$\frac{\sigma_{Pb^{208}}}{\sigma_{U^{238}}} < 4 \times 10^{-5} \qquad \frac{\sigma_{Bi}}{\sigma_{U^{238}}} < 7 \times 10^{-5}$$

In view of the many uncertainties, including iodine yields in fission, energy losses of the neutrons through scattering in the material and the surroundings, and dependence of cross-sections on energy above the thresholds, the figures must be considered as very approximate only.

We want to express our thanks to Prof. N. Feather for helpful discussions, and to Mr. W. Birtwhistle for running the Cambridge High Tension set. This investigation was carried out between January and April 1945 in the Cavendish Laboratory, Cambridge, for the Directorate of Tube Alloys.

E. BRODA
P. K. WRIGHT

Department of Natural Philosophy,
University, Edinburgh.
Nov. 15.

[1] Mattauch and Flugge, "Kernphysikalische Tabellen" (Berlin, 1942) 66.
[2] Libby, *Phys Rev.*, 55, 1269 (1939).
[3] Richards, *Phys. Rev*, 59, 796 (1941); extrapolated to lower energies in agreement with Bonner and Brubaker, *Phys. Rev.*, 48, 742 (1935).

Determination of the Upper Limits of the Fission Cross-sections of Lead and Bismuth for Li-D Neutrons by a Track Count Method

FOLLOWING the unsuccessful search for fission of lead and bismuth by a chemical method[1], an attempt was made using track counts in irradiated 'loaded' plates. It is possible through desensitization (bathing for 5 min. in 1 per cent chromic acid, rinsing with water and drying) before irradiation to suppress fogging by γ-rays and the proton recoil tracks due to the fast neutrons[2]. Therefore the plates can be exposed to very high doses of fast neutrons. α-Ray tracks from uranium are weakened in the desensitized plates, but fission tracks from uranium still stand out boldly, and are easily identified and counted under a microscope (× 1,500).

The plates used were Ilford Concentrated Half-Tone Plates of emulsion thickness 20 μ [3]. The plates were loaded by a 30 min. bath in bismuth lactate solution in 10 per cent acetic acid, or alternatively, in lead acetate solution in 10 per cent acetic acid, quickly rinsed with water and dried. Monitor plates were made by impregnation in the same way with uranyl acetate in 10 per cent acetic acid. The area concentrations of bismuth (0·082 mgm./cm.^{2} = $3{\cdot}9 \times 10^{-7}$ gm.-atom/cm.^{2}) and lead (0·296 mgm./cm.^{2} = $14{\cdot}3 \times 10^{-7}$ gm.-atom/cm.^{2}) in the emulsions were estimated gravimetrically by converting the bismuth and lead salts from a known area into bismuth oxide and lead sulphate after separation from silver bromide. The concentration of uranium in the monitor plate was derived from a count of the (U^{234} and U^{238}) α-ray tracks in a (not desensitized) plate which was allowed to stand for several hours. The result was 6·0 tracks in 8·4 hr. per field of view ($7{\cdot}85 \times 10^{-5}$ cm.^{2}) corresponding to a concentration of $4{\cdot}4 \times 10^{-7}$ gm.-atom U/cm.^{2}.

It is found that strong loading with heavy metals, besides distorting the tracks, has a desensitizing action of its own towards α-rays. Hence a special check was applied to find whether fission tracks would be visible in the lead and bismuth plates. Plates identical with those in the main experiments, but containing small amounts of uranium in addition, were exposed to neutrons, and the presence of the fission tracks—though in a weakened condition—was established.

The plates were irradiated with neutrons from the lithium hydroxide target of the Cambridge High Tension set, bombarded with 900 keV. deuterons for 2¾ hours in the bismuth experiment and 4 hours in the lead experiments. The brass box holding the plates actually touched the target tube. In each plate

1,000 fields of view were searched for fission tracks, and none was found. The number of fission tracks in the monitor plates were 6·8 and 6·9 per field of view. To have an ample safety margin, it will be assumed merely that there is, then, less than one fission track per 300 fields of view in each case. The cross-sections σ, in terms of $\sigma_{U^{238}}$, are given by

$$\frac{\sigma}{\sigma_{U^{238}}} < \frac{c_U}{c}\,\frac{N}{N_U}$$

where c are the concentrations, and N the track counts. Hence,

$$\frac{\sigma_{Pb}}{\sigma_{U^{238}}} < \frac{4\cdot4 \times 10^{-7}}{14\cdot3 \times 10^{-7}} \times \frac{0\cdot0033}{6\ 9} < 1\ 47 \times 10^{-4}$$

$$\frac{\sigma_{Bi}}{\sigma_{U^{238}}} < \frac{4\cdot4 \times 10^{-7}}{3\ 9 \times 10^{-7}} \times \frac{0\ 0033}{6\cdot8} < 5\cdot5 \times 10^{-4}.$$

Referring again to individual isotopes and 'effective' neutrons[1], we get

$$\frac{\sigma_{Pb^{206}}}{\sigma_{U^{238}}} < 1 \times 10^{-3} \qquad \frac{\sigma_{Pb^{207}}}{\sigma_{U^{238}}} < 1 \times 10^{-3}$$

$$\frac{\sigma_{Pb^{208}}}{\sigma_{U^{238}}} < 5 \times 10^{-4} \qquad \frac{\sigma_{Bi}}{\sigma_{U^{238}}} < 8 \times 10^{-4}$$

These limits are, of course, independent of any assumption about the mode of the hypothetical fission of lead or bismuth.

I want to thank my colleagues, L. L. Green and D. L. Livesey, for much information about the desensitization of plates and Mr. W. Birtwhistle for running the Cambridge High Tension set. This investigation was carried out between January and June 1946 in the Cavendish Laboratory, Cambridge, for the Department of Atomic Energy.

E BRODA

Department of Natural Philosophy,
The University,
Edinburgh.
Nov. 15.

[1] See preceding communication
[2] Cf. Green and Livesey, *Nature*, 158, 272 (1946).
[3] Cf Powell, Occhialini, Livesey and Chilton, *J. Sci. Instr.*, 23, 102 (1946).

Use of Lead Sulphide Cells in Infra-red Spectroscopy

THE photoconductive properties of lead sulphide when irradiated by wave-lengths between 1 and 3·5 μ were first utilized as a means of detecting infra-red radiation during the War by the Germans. In the later stages, lead sulphide detector cells were developed by the Admiralty[1] and in the United States[2], for within their range of operation they are far superior to any other detector in speed and sensitivity. The purpose of the present note is to indicate their possibilities as a tool in infra-red spectroscopy, and to describe some of our results in applying them to the attainment of high resolving power in the near infra-red region of the spectrum. The cells used by us were made at the Admiralty Research Laboratory by the evaporation process, and were cooled to a temperature of about − 78° C. by a mixture of solid carbon dioxide and acetone.

The variation of sensitivity with wave-length of a typical lead sulphide cell is shown in Fig. 1. It will be noted that the sensitivity is by no means uniform; it rises to a maximum at 2·6 μ and then falls steeply

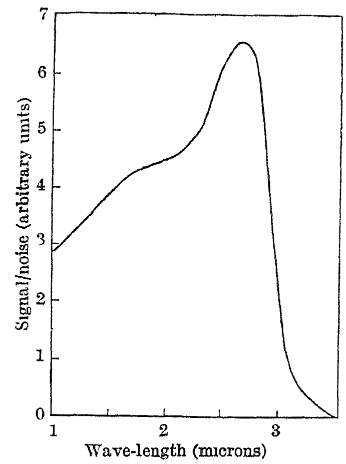
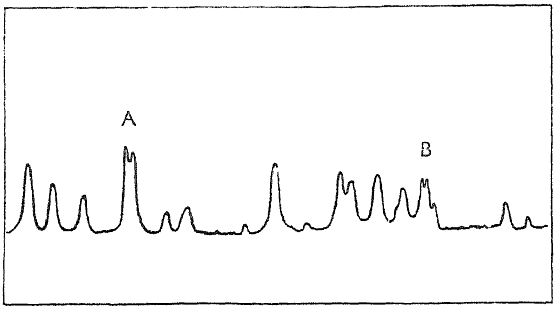


Fig. 1

until at about 3·4 μ it becomes inferior to the thermocouple. We have found that appreciable sensitivity persists until about 3·6 μ. The fact that the sensitivity of the lead sulphide cell greatly exceeds that of the best thermocouple only below 3 μ means that its use in the examination of fundamental frequencies is virtually restricted to NH, OH and FH frequencies. However, the first overtone of practically any fundamental stretching frequency involving a hydrogen atom will occur at wave-lengths shorter than 3 μ and so will be accessible to the new detector. In other words, any molecule containing a hydrogen atom should have at least one overtone frequency which can now be examined under higher resolving power than has ever been possible hitherto.

It is not yet possible to state precisely the exact increase in resolving power available, since we find that lead sulphide cells vary considerably in performance; and it is by no means certain either that the maximum sensitivity has been reached, or that the best design for spectroscopic work has been produced. However, there is no doubt from our experiments that the signal/noise ratio for the lead sulphide cell at its point of maximum sensitivity is of the order of 100 times that of the Hilger–Schwarz thermocouple. This would imply that slit-widths could be reduced by a factor of 10 in going from thermocouple to lead sulphide detector, with a corresponding increase in resolving power. In practice, such an increase may not be attainable because of purely optical considerations, for example, aberrations or diffraction limits. Thus in our experiments with a grating spectrometer we find that reduction by a factor of 4 brings us to the diffraction limit. This is a point which we wish to emphasize: namely, if the full possibilities of the lead sulphide cell are to be realized, much more attention will have to be paid to the optics of infra-red spectrometers than in the past, when the resolving power was nearly always limited by the sensitivity of the detector.

An example of the increased resolving power which we have already achieved is given in Fig. 2, which shows a portion of the H_2O band at 3970 cm.$^{-1}$ obtained with a non-echelette grating of 14,400 lines/inch. The separation of the lines in the doublet marked A is 0·25 cm.$^{-1}$ and of those in the doublet B is 0·14 cm.$^{-1}$. The slit width employed was 0·08 cm.$^{-1}$. The closest pair of lines previously resolved in this band had a separation of 0·6 cm.$^{-1}$, namely, the pair at 3566·2 and 3566·8 cm.$^{-1}$ resolved by Nielsen[3] using a grating



Frequency increasing ⟶

Fig. 2

spectrometer with thermocouple detector. It seems probable that in the future the limit of resolving power in the near infra-red will be of the order of 0·05 cm.$^{-1}$, compared to a pre-war limit of 0·5 cm.$^{-1}$.

We would also emphasize the great advantages to be derived from the exceptional speed of response of the lead sulphide detector, which has a time constant of considerably less than 0·001 sec. compared to the Schwarz thermocouple of about 0·1 sec. and the thermistor bolometer of about 0·01 sec. Quite apart from the increased speed with which spectra can be plotted, this short time-constant allows one to chop the radiation at a high frequency (we actually used 800 c./sec.) and employ a tuned detector system which entirely eliminates drift. Furthermore, the use of a lead sulphide cell in connexion with our cathode ray presentation of spectra[4] will allow much higher scanning speeds than can be achieved with a bolometer. This means that a more truly instantaneous picture of the spectrum can be obtained, or alternatively a wider range of the spectrum can be viewed continuously, than with a bolometer.

A full description of these results will be published shortly elsewhere.

We wish to acknowledge our indebtedness to the Admiralty for the loan of the cells used, and to the Telecommunications Research Establishment at Malvern for the loan of the amplifier equipment.

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Angular Momentum of the Solar System

ONE of the main difficulties to be met by any theory about the origin of the solar system is the difficulty of accounting for the present distribution of its angular momentum.

This difficulty can be stated in the following way. If the material of the planets has originated from the sun, it is difficult to understand why the average angular momentum per unit mass of the planetary material should be about 50,000 times larger than the average angular momentum per unit mass of the solar material. If, however, the planetary material was at the beginning present in a nebula around the sun, the density of this nebula was too small for a condensation into solid bodies under the sole influence of the gravitational forces (Roche). If, finally, the condition from which the evolution started was such that the material of the sun and the planets together was smoothed out in a nebula, the total angular momentum of the system was far larger than at present, in contradiction with the law of the conservation of angular momentum.

The apparent failure of the theories of Kant and Laplace to explain this point has led to several 'catastrophic' theories being put forward. Von Weizsacker[1] gives in his recent theory, which is along the lines originally proposed by Kant and Laplace, an explanation which is, however, not completely convincing

It seems, however, that it may well be possible to account for the present distribution of the angular momentum, without introducing interactions with foreign bodies, if we take into account that the condensation into planets will probably not take place under the influence of the gravitation alone, but will be a consequence of a process of condensation similar to that occurring in a supersaturated vapour, or to the process of the formation of smoke particles in interstellar space, as has been remarked already by Lindblad[2] and Jeffreys[3].

We may start thus from a situation where the sun is surrounded by a rotating nebula possessing an angular momentum which is about equal to the total angular momentum of the planetary system at present. The fact that the density in this nebula will be too low to allow condensation by gravitational action no longer prevents the actual condensation, since this condensation can proceed in the way mentioned above.

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Physical Basis of a New Theory of Absorption of Ultrasonics in Liquids

THE relaxation theory of Kneser[1], the diffusion theory of Lucas[2], and other theories[3] have not satisfactorily explained the excessive absorption of ultrasonics in liquids, unaccompanied by any sensible dispersion. In the following we offer a possible mechanism for the phenomenon.

The relevant difference in the structure of gases and liquids is that in the former the rupturing tendency indicated by kT is much more than the cohesive tendency of intermolecular attraction forces, whereas in liquids the reverse is the case. In gases we picture the molecules as free except at collisions, on which occasion they rearrange their energies in different degrees of freedom. But the distances to be reached in collisions in gases are already nearly reached in liquids at all times, and so the conditions arising at collisions in gases lose their force in explaining the characteristic phenomena in liquids, for these conditions were present all the time. The existence of this fundamental difference becomes evident on examining the opposite temperature variation of compressibility and viscosity in gases and in liquids. In a liquid and in the ordinary state, the electron atmospheres of the molecules are affecting each other at the close intermolecular distances existant, due to their property of polarizability. In fact, London's dispersion forces[4] are due to this mutual polarization of electron atmospheres. Our theory of absorption of ultrasonics is a further use of this mutual interaction of electron atmospheres.

We postulate that under compression brought about by ultrasonic waves, the electron atmospheres are perturbed still further, and interatomic vibrations are started. The validity of this assumption and the actual mode of starting vibrational motions have been reviewed by Oldenbergh and Frost[5]. On the approach of a molecule to a second molecule, the equilibrium internuclear distances of the atoms in the molecules change, due to the mutual distortion of the electron atmospheres. As the atoms move to occupy their new positions they overshoot the mark and vibrations result, absorbing energy. This vibrational energy is inelastic and is frittered away in the form of heat and other degrees of freedom, and constitutes a loss of ultrasonic energy.

The smaller the $h\nu$ of a particular vibration in relation to kT, the greater will be its probability of excitation. But it is to be noted that whereas, on the relaxation theory, a quantum greater than kT may not be sensibly excited at all, it has greater probability of excitation on the mechanism postulated[5].

The following phenomena are readily explained on this theory. (1) Good scatterers of light are good absorbers of sound. Richardson[6] first noted this fact. The scattering of light depends upon the square of the polarizability; this follows from the fact that the mutual interaction of electron atmospheres depends upon polarizability. (2) Classical absorption of mercury, for there are no interatomic vibrations to be excited.

Other points cleared up by the new mechanism are: (*a*) The greater the compressibility, the greater the absorption. The relative change of intermolecular distance and hence perturbation of electron atmospheres will increase with compressibility. This consideration still further increases the correspondence between absorption of sound and light scattering. Now, in general, polarizability and compressibility, as follows from London's theory of dispersion forces, vary in the opposite direction, but when they are both great, sound absorption is excessive. For example, carbon disulphide shows an absorption a thousand times the classical value. (*b*) The mechanism explains the effect of temperature and pressure on absorption, its variation with frequency and the fact that, in general, liquid mixtures show greater absorption than is shown by the components.

Again, the apparently unconnected phenomena of splitting up of heavy molecules by ultrasonics and faint emission of light by liquids carrying ultrasonics seem to be explained by the new mechanism. The details of the theory will be published elsewhere.

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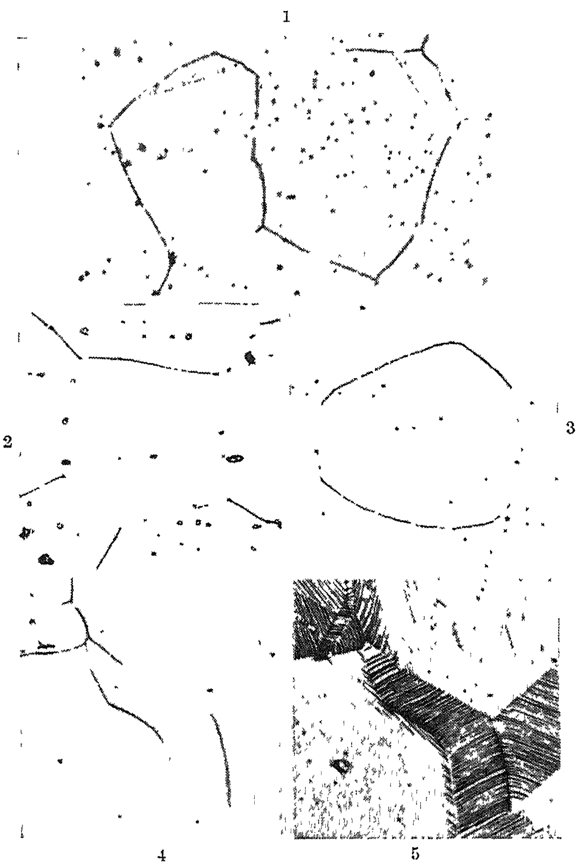
Grain Boundaries in Metals

ACCORDING to the transition lattice theory, since in pure metals and single-phase alloys the only difference between the two grains which meet at a boundary is one of direction, the atoms at the boundary take up positions representing a compromise between the two crystal lattice directions. There thus exists a region, a few atomic diameters in thickness, over which a state of disorder exists, the extent of which will be expected to depend upon the relative orientation of the two lattices; there will exist angles for which this disorder is a minimum, an obvious example being the twinning angle. In addition, the direction of the boundary itself relative to the grains would be expected to produce an effect. Lateral misalignment of crystal planes would also be expected to produce 'lack of fit' at the grain boundaries, but this effect is most probably smoothed out by the imperfections in the crystal structure. It would be expected, therefore, that any phenomenon depending upon the degree of disorder existing at the boundary would vary in magnitude according to the relative orientations of the grains meeting at the boundary, and with position in the boundary between two given crystal grains if the boundary changed in direction. It is reasonable to suppose that where precipitation of a second phase occurs from the supersaturated solid solution, it occurs more readily in those regions where disorder is greatest, and it would, therefore, be expected that grain boundary precipitation would vary in this manner.

Fig. 1 shows a copper–beryllium alloy in which precipitation has occurred at the boundaries. Twinning has occurred in this specimen, and in certain cases the abrupt change in relative orientation of two grains caused thereby produces an equally abrupt change in the precipitation. Furthermore, this change is reversed and repeated where there are a number of twins. Fig. 2 shows an aluminium–5 per cent magnesium alloy in which the boundaries are revealed by the precipitation of discrete particles of the β-phase. The degree of precipitation is very different for different boundaries.

In these two cases the change of precipitation may be due to the change in relative direction of the crystals or the change in direction of the boundary, or to both together. That the direction of the boundary is significant is indicated by Fig. 3, which shows an isolated grain in a copper–beryllium alloy completely surrounded by another grain. There are marked differences in the degree of precipitation around the boundary, yet the relative orientation of the grains is not changed. While the fact that the portions of the boundary showing minimum precipitation are substantially parallel would appear to be in strong support of this explanation, too much significance may not be attached to this as the direction of the boundary within the metal is not known. It is possible, too, that the surrounding material is not, in fact, a single crystal but is composed of a number of grains the orientations of which are so near together that the boundaries are not indicated by precipitation. If this were so, the above argument would still hold.

Another phenomenon associated with the degree of disorder at the boundary is that of the formation of boundary grooves on polished metal surfaces at elevated temperatures[1]. It has been observed that the grain boundary grooves which develop on the surface of electrolytically polished high-purity silver



(1) Copper-beryllium alloy, electrolytically polished, chemically etched × 1,000
(2) Aluminium-magnesium alloy, electrolytically polished, chemically etched. × 500
(3) Copper-beryllium alloy, electrolytically polished, chemically etched. × 750
(4) Silver, electrolytically polished, thermally etched in nitrogen. × 200
(5) Silver (same field as 4 after subsequent heating in air). × 200

show similar variations to those shown by the precipitation in Figs. 1, 2 and 3. Fig. 4 shows the appearance of a specimen of silver after alternate heating in nitrogen and air at 920° C., the last heating being in nitrogen. There is one example of a grain boundary groove which changes its appearance with change of direction, and three cases of grooves which terminate abruptly. Fig. 5, of the same surface after a subsequent heating in air, reveals the presence of twins, showing that abrupt termination of the boundary groove is due to the change in orientation produced by twinning.

In the case of thermally etched silver, since the etching takes place on a prepared surface, the orientation of the boundary relative to the free surface would be expected to have an effect. This might contribute to the change in nature of the boundary groove where it changes direction, but not to the abrupt change where twinning occurs. The variations in precipitation are, of course, not subject to the effect of the surface, since precipitation occurs in the body of the material before the surface is prepared.

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Fungistatic Activity of Ethylenic and Acetylenic Compounds

In a recent discussion of the lachrymatory activity of some ethylenic compounds, Dixon and Needham[1] have suggested that lachrymatory properties are conferred by certain substituent groups (ketone, aldehyde, ester, nitro-, etc.) which polarize the adjacent olefinic linkages, rendering them reactive towards nucleophilic reagents.

We have studied the fungistatic activity of a considerable number of ethylenic and acetylenic compounds and had developed a similar theory to account for fungistatic activity. In view of Dixon and Needham's results, and observations we have made on bacteriostatic activity, we now consider that it may be more correct to suppose that substituent groups which tend to attract electrons confer general toxicity on living cells, the specific type of toxicity being conditioned by other factors.

The lack of parallelism between fungistatic activity and physiological effects on man (see examples in accompanying table) affords support for this view.

Compound	Fungistatic activity*	Physiological effect on man
β-Nitrostyrene	6·25	Powerful sternutator
4-Methoxy-β-nitrostyrene	7·8	Non-irritant
Cinnamic aldehyde	125·0	Pleasant aromatic odour
Ethyl acrylate	>1000·0	Unpleasant pungent odour
Ethyl propiolate	>1000·0	Highly lachrymatory

* Expressed as least concentration (μgm./ml.) inhibiting germination of *Botrytis allii* conidia

In one respect our observations have been similar to those of Dixon and Needham. Just as they found acids to be less lachrymatory than their corresponding methyl or ethyl esters, so we have found them to be less fungistatically active. We do not consider that this is due to the carboxyl group being ineffective in producing the necessary electromeric displacement, as suggested by Dixon and Needham. On the contrary, there is considerable evidence[2-5] that the carboxyl group (though not the carboxyl ion) is a group which attracts electrons, and we consider that these observed differences in activity are more readily explained by the well-known greater permeability of living cells to esters than to acids.

Our results will shortly be published in detail elsewhere.

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Antibacterial Activity in Members of the Native Australian Flora

We are carrying out a survey of the native flora of Australia for the presence of antibacterial substances. Much of this flora is unique and may well provide new and interesting antibiotics.

Atkinson and Rainsford[1] recorded the results of a preliminary investigation of 410 species of flowering plant native to Australia, and afterwards another group comprising about seven hundred species was examined. The tests were made against the Gram-positive type *Staph. aureus* and the Gram-negative type *Bact. typhosum*. Out of a total of approximately 1,100 species, about fifty showed antibacterial activity against *Staph. aureus*, but only four of these, namely, *Drosera Whittakeri* and three species of *Persoonia*, also affected *Bact. typhosum*. Substances active against both Gram-positive and Gram-negative bacteria are of special interest on account of their possible potential value in the chemotherapy of a wide range of infections. These four plants were therefore selected for more extensive examination.

The activity appeared in extracts of leaves and stems of the *Drosera* and in extracts of the berries of the *Persoonias*. Bulk extraction of the active parts of these plants was carried out, and attempts are being made to purify the active substance. Some characterization of the *Persoonia* substance has so far been achieved. In crude extracts, the activity was greater against *Bact. typhosum* than against *Staph. aureus*. This activity was readily destroyed by alkalinity (pH 9) but persisted in acid solution (pH 2) for several hours at least, and was not destroyed by heating at 100° C. for at least 45 minutes. Crude extracts kept at 4° C. retained their activity for at least eight months. The active substance did not appear to be volatile in steam; it was absorbed by charcoal, from which it was partly recovered by elution with ethyl alcohol. Work on further purification of this material is proceeding.

The majority of the other plants active only against *Staph. aureus* belonged to the Myrtaceæ, a family well represented among the native Australian flora. Further investigation of *Chamælaucium uncinatum*, in which activity was detected only in the flowers, and *Darwinia citriodora*, in which activity appeared in both flowers and leaves, located the antibacterial substance in the oil obtained by steam distillation of the active part of the plant. These oils have provoked our interest because they exhibited antibacterial activity against *Myco. phlei*, an acid-fast bacillus. Any material showing action against the Mycobacteria is worthy of attention; these oils are therefore undergoing fractionation with the object of isolating the active constituents.

Detailed reports of this work will appear elsewhere.

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Action of Thionyl Chloride on Carboxylic Acids in Presence of Pyridine

THE catalytic effect of small amounts of pyridine in the reaction between thionyl chloride and carboxylic acids is well known; Carré and Libermann[1] have shown further that it is of great advantage to use equimolar quantities of acid, pyridine, and thionyl chloride, the acid chloride then being formed rapidly at lower temperatures, in high yield. This convenient method apparently has not been very widely used, and instructions for making acid chlorides generally call for the use of excess thionyl chloride and 'a few drops' of pyridine.

Finding it necessary to prepare substituted amides from the hydrogen phthalates of secondary alcohols, we have followed a process essentially the same as that of Carré and Libermann, but have prepared and tested for the intermediate acid chlorides in solution, without attempting to isolate them. This method has given very good results, and would seem to be generally applicable to the preparation of derivatives from acids which are too unstable to withstand the action of heat or excess thionyl chloride.

In general, the acid was dissolved in ten volumes of dry solvent (ether was preferred, but benzene, chloroform or carbon tetrachloride could be used) treated with one equivalent of dry pyridine, and then exactly one equivalent of purified thionyl chloride[2] was added, drop-wise with stirring. Pyridine hydrochloride separated, except when chloroform was the solvent, and the mixture was left at 15–20° for an hour. The alcohol or amine to be coupled with the acid chloride was mixed with one equivalent of pyridine, and added drop-wise with stirring; then the ester or amide was recovered and purified by the usual methods From *cyclo*hexyl hydrogen phthalate, by the action of thionyl chloride and pyridine, followed by coupling with aniline, we obtained *cyclo*hexyl phthalanilate, m.p. 111·5°, in yields exceeding 80 per cent.

Experiments by L. H. Darling indicate that esters made by this general method may contain traces of sulphur compounds, and are unsuitable for catalytic hydrogenation.

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Measurement of the Photodynamic Effect of Cancerogenic Substances with Biological Indicators

THE photodynamic effect of cancerogenic substances was examined by Mottram and Doniach[1] using *Paramecium*. They found that the cancerogenic substances had a stronger effect than the non-cancerogenic photosensitizers. We have tried to estimate the photodynamic effect of cancerogenic substances by means of a standard biological indicator, namely, the 3rd stage larvæ of *Drosophila melanogaster*, as it is known that they are suitable for the standardizing and measuring of radiation.

We used for the experiments a five years inbred white-eyed strain (white 4 ch. 1·5 Morgan unit). To 13 gm. standard *Drosophila* food we added 1 mgm. benzpyrene, methylcholanthrene or dibenzanthracene, and the imagos on this food laid eggs. The animals were in the dark. We found by fluorescence microscopy that the cancerogenic substances were in the organs and cells in a dissolved state. We radiated groups of some forty larvæ with a quartz mercury lamp (Hanau type Jubiläums Höhensonne 2·5 amp., 220 V.) from a distance of 36 cm. at 24–26° C. Their death was observed under these conditions, and the duration of the radiation was noted.

The control larvæ, which were bred on standard *Drosophila* food, died after 39 min. 51 sec. ± 4 min. 17 sec. The larvæ treated with benzpyrene died after 6 min. 30 sec. ± 1 min. 15 sec.; with methylcholanthrene after 13 min. 35 sec. ± 1 min. 57 sec.;

with dibenzanthracene after 19 min. 34 sec. ± 3 min. 35 sec.

It is evident that the benzpyrene has the strongest photodynamic effect; after this comes methylcholanthrene, and dibenzanthracene is last. Roughly speaking, methylcholanthrene has a half, dibenzanthracene a third, as strong photodynamic effect as benzpyrene. The benzpyrene-treated larvæ perished with a sixth of the ultra-violet radiation required for the controls, the methyl-cholanthrene-treated larvæ with a third, and the dibenzanthracene-treated larvæ with half as much.

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Action of Heparin on the Venom of *Echis carinatus*

AHUJA *et al.*[1] have presented experimental evidence to show that heparin is capable of neutralizing the blood-coagulant action of Russell's viper venom *in vitro* and of counteracting to a considerable extent the toxicity of this venom *in vivo*. Further studies were undertaken to find out if heparin exerted a similar action on the venom of the other common Indian viper, *Echis carinatus*. The venom used in the experiments was obtained through the courtesy of the director of the Haffkine Institute, Bombay. It was a well-dried sample composed of a mixture of the venom extracted from several *Echis* vipers.

Heparin was a solution in physiological saline of the sodium salt of heparin of a strength of 10 mgm. per ml., each mgm. representing 110 Toronto units approximately.

TABLE 1. ACTION ON BLOOD-COAGULANT ACTIVITY OF *Echis* VENOM *in vitro*

Echis venom (mgm.)	Heparin (mgm.)	Sheep blood (ml.)	Result
0·1	Nil	1·0	Clot 36 sec.
0·1	1·0	1·0	Clot 2 min. 35 sec.
0·01	Nil	1·0	Clot 42 sec.
0·01	1·0	1·0	Clot 8 min. 25 sec
0·001	Nil	1·0	Clot 2 min. 15 sec.
0·001	1·0	1·0	Clot 90 min.
0·0001	Nil	1·0	Clot 4 min. 55 sec.
0·0001	1·0	1·0	No clot 8 hr.; clot 24 hr.
Nil	Nil	1·0	Clot 8 min
Nil	1·0	1·0	No clot 24 hr.

It will be seen from Table 1 that (*a*) 1·0 mgm. of heparin in the presence of 0·01 mgm. of *Echis* venom can prolong the clotting time of blood from 42 sec. to 8 min. 25 sec., which is the normal clotting time of sheep blood; and (*b*) 1 mgm. of heparin is unable to prevent the coagulant action of even 0·0001 mgm. of *Echis* venom, although it can prolong the clotting time from 4 min. 55 sec. to 8 hours.

TABLE 2. ACTION ON TOXICITY OF *Echis* VENOM *in vivo*
Echis venom and heparin mixed, incubated at 37° C for 30 minutes and the mixture given intravenously to rabbits

Rabbit weight (gm.)	Venom (mgm.)	No. of lethal doses injected	Heparin (mgm.)	Result
1275	0·02	2	Nil	Died 1 min
1650	0·01	1	Nil	Died 19 min.
1875	0·01	1	Nil	Died 15 min.
1725	0·005	½	Nil	Survived
1800	0·01	1	5	Survived
1885	0·1	10	7	Survived
1480	0·2	20	15	Survived
1500	0·2	20	15	Survived
1650	0·3	30	30	Died 10 min.
1695	0·3	30	50	Died 3½ hr.

The minimum lethal dose of *Echis* venom for rabbits was found to be 0·01 mgm. This dose consistently killed the animals in 15–20 min. when given intravenously. When *Echis* venom was mixed with heparin and given intravenously, the animals did not die even though the dose of venom injected was twenty times the lethal dose. With the dose of venom increased to 30 times the lethal dose, even 50 mgm. of heparin could not save the animal.

In the light of our previous studies on the action of heparin on the venom of *V. russellii*, in which it was shown that one part by weight of heparin could effectively counteract *in vivo* the lethal action of at least an equivalent amount of Russell's viper venom, the results obtained with *Echis* venom show that: (1) comparatively a much larger quantity of heparin is required to counteract the toxic effect of *Echis* venom under experimental conditions *in vivo*; (2) weight for weight, *Echis* venom is a much more powerful blood coagulant than the venom of *V. russellii*; and (3) when the dose of *Echis* venom injected is increased beyond certain limits, namely, twenty times the minimum lethal dose, some of the animals show paralysis of the limbs and gradually increasing respiratory failure as against the usual convulsive seizures seen with smaller doses. It is possible that with higher doses, toxic fractions other than the one responsible for intravascular coagulation, for example, neurotoxic or hæmorrhagic fractions, increase from a sub-lethal to a lethal level. Heparin is obviously ineffective against these other fractions.

In view of the fact that *Echis* is a small snake which seldom gives more than one or two lethal doses in a full bite in man, and that, too, subcutaneously, these results are sufficiently encouraging to warrant the therapeutic trial of heparin in cases of *Echis* bite, particularly when specific antivenene is not available.

We are indebted to Messrs. Eli Lilly and Co. for the supply of heparin used in these experiments.

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Action of Mustard Gas on the Bone Marrow

IN their article on "Biochemical Research on Chemical Warfare Agents", Dixon and Needham[1] refer to the work of Wormall and his co-workers[2] on the distribution of mustard gas (H.) in the organs of rabbits which have been injected with a preparation of H. containing radioactive sulphur. It was found that the bone marrow contained only about one twentieth of the amount detected in the kidneys and lungs. Dixon and Needham go on to say: "It is surprising that marrow, the tissue most damaged, had the lowest H. content, while the two tissues with by far the highest H. content are practically undamaged by H. poisoning". They then develop a theory to account for these findings.

This interpretation, however, ignores the finding that mustard gas exercises drastic effects on the nucleus. It is capable of breaking chromosomes and thus interferes with mitosis or inhibits it altogether[2–4].

This effect will obviously be observed essentially in still actively dividing tissues, which will thus be expected to be particularly sensitive to the action of mustard gas. In accordance with this expectation, it has been found[5] that in the adult *Drosophila*, in which the only organ with actively dividing cells is the gonad, mustard gas produces a selective action on gametogenesis, while in developmental stages of the same flies, doses of mustard gas which affect the germ cells are usually harmful or definitely lethal to the animal as a whole, presumably because cells in many other tissues are also actively dividing.

In adult mammals the bone marrow is one of the few tissues in which cell division is actively proceeding. It is, therefore, not surprising that it is also highly sensitive to the action of mustard gas, even though it only contains comparatively small amounts of it.

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Specific Serological Characters of the Mucoids of Hog Gastric Mucin

The demonstration that purified and apparently homogeneous specimens of 'A-substance' prepared from commercial hog gastric mucin possess both A and O blood-group specificity, whereas A-substance isolated from the fluid contents of human pseudomucinous ovarian cysts[1] shows no significant O activity, suggested that a closer and more detailed examination of the hog mucin 'A-substance' for homogeneity should be undertaken. The best specimens of A-substance of animal origin examined so far have been obtained from commercial preparations of hog gastric mucin or pepsin[2], each batch of which contains material from the stomachs of many hogs. In view of the differences known to exist in the serological specificity of the gastric secretions of man[3], it seems not improbable that similar serological differences exist in the mucin preparations derived from individual hog's stomachs, and an examination of the serological properties of the mucoids isolated from single stomachs was therefore undertaken.

The individual stomach linings were finely chopped and were allowed to autolyse at pH 3–4 and at 37° for several days in the presence of toluene. The tissue undigested after this time was removed by centrifugation, the resulting opalescent supernatant fluid was treated with three times its volume of ethanol, and the precipitate, which contained the serologically active material, was dissolved in water, dialysed and reprecipitated with alcohol. Mucoid material was obtained in this way from twenty-four stomachs, and a serological examination of the preparations revealed that fourteen possessed A specificity only, whereas those remaining showed O specific character alone. It is noteworthy that in the series examined, no preparation of mucoid possessed both A and O specificity, as did the mucoid material obtained from hog gastric mucin of commercial origin, and no specimen was without either A or O character. The occurrence in hog gastric mucin of a mucoid material which possesses a single serological character that is very similar to, if not identical with, the human blood group O factor is thus demonstrated. The mucoid possessing O-specificity alone is presumably the material recently described as inactive mucoid by Bendich, Kabat and Bezer[4] as a result of their careful studies on the A-specific component of mucoid preparations obtained from individual hog stomachs.

Up to the present time, no technique for the isolation of the blood-group substances has been described that involves more than a few simple chemical and physical methods, and it is not surprising, therefore, that the application of these techniques fails to separate the blood-group substances one from the other in a mixture of A and O mucoids such as arises when a purified 'A-substance' is obtained from commercial hog mucin. The very similar chemical and physical properties and behaviour of the specific blood-group factors, and of the closely related but inactive mucoids which undoubtedly occur in native tissue fluids and secretions, forced one to rely on serological techniques for their differentiation, and it has been found that the success or failure of special techniques elaborated to separate the mucoids in mixtures of this kind can be readily followed by determining, by means of quantitative inhibition tests, the ratio of the activity of the appropriate specific characters, in this instance the A and O activity, of the separate fractions obtained. Inactive mucoids, that is, those not possessing A, B or O specificity, can be detected in the presence of material showing these specific blood-group characters by means of this type of agglutination test.

The behaviour of electrophoretically homogeneous hog mucin 'A-substance' after fractionation from solution in water, formamide, ethylene and diethyleneglycol, 90 per cent acetic acid–ammonium acetate mixture (a method investigated in this Institute by Dr. H. Laurell) and 90 and 95 per cent phenol, has revealed that at least a partial separation of the A and O components can be achieved by the use of some of these simple procedures.

Full details of this work and the application of the techniques to artificial and natural mixtures of biologically important mucoid substances will be given elsewhere.

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Effect of Cholera Filtrate on Red Cells as Demonstrated by Incomplete *Rh* Antibodies

RED cells sensitized with an incomplete (blocking) anti-*Rh* antibody will agglutinate if suspended in serum[1,2] or in concentrated albumin[3], or, having been washed, are exposed to an anti-human precipitating serum[4]. During an investigation in which the properties of red cells from cases of acute acquired hæmolytic anæmia were compared with red cells 'changed' by a filtrate of a broth culture of cholera vibrio, it was found that red cells previously sensitized by an incomplete antibody, and washed, were agglutinated after incubation with the cholera filtrate. Normal cells when so treated do not show any alteration until they are in contact with serum, when they show panagglutination as in the Hubener Thomsen phenomenon[5]. The 'T' agglutinin responsible for the panagglutination is present in all normal sera and can be specifically absorbed by 'changed' cells; when incomplete anti-*Rh* sera are so absorbed and incubated with red cells, together with cholera filtrate, they show specific agglutination of *Rh*-positive cells. These reactions are shown in the accompanying table.

	Cell type *Rh*+	*Rh*−
Cholera filtrate + red blood cells + non-immune serum	+	+
Cholera filtrate + red blood cells + non-immune serum ('T' agglutinin absorbed)	−	−
Cholera filtrate + red blood cells + incomplete anti-*D* serum	+	+
Cholera filtrate + red blood cells + incomplete anti-*D* serum ('T' agglutinin absorbed)	+	−
Incomplete anti-*D* serum + red blood cells (washed after incubation) + cholera filtrate	+	−
Incomplete anti-*D* serum + red blood cells (washed after incubation) + anti-human precipitating serum	+	−

The absorption of the 'T' agglutinin does not alter the reactions or the titres of the isoagglutinins or immune agglutinins; nor does incubation of the incomplete anti-*Rh* serum with cholera filtrate change the serum into the complete or agglutinating form. Absorption experiments show that the cholera filtrate does not affect any known hæmagglutinogen loci on the red cell, but Burnet *et al.*[6] have shown that it removes the virus receptors. The factor in the filtrate responsible for changing the red cells is adsorbed on them, and after acting on them is released again, and can be recovered in saline. The saline extract can 'change' further red cells, and also causes agglutination of sensitized cells. Heating to 56° C. for 30 min. diminishes activity. From its reactions it appears to have the properties of an enzyme, possibly a lecithinase which has been described in cholera filtrate by Felsenfeld[7], but preliminary work on the saline extract by Miss M. G. Macfarlane, at the Lister Institute, London, failed to reveal any lecithinase activity.

Four strains of cholera vibrio (stock strain of the Department of Pathology, Oxford, and National Type Cultures Nos. 1548, 4693 and 5596) have been tested, and all except No. 1548 showed activity: of two strains of El Tor (stock strain of the Department of Pathology, Oxford, and National Type Culture No. 4714) only the former showed activity. All were grown for 48 hours in peptone water at *p*H 7·2. The Oxford strain of cholera vibrio has been tested with twenty incomplete anti-*D* and one incomplete anti-*c* serum, and has given specific reactions in parallel with the human albumin and Coombs' tests. It has also given positive results in cases of *in vivo* sensitization in hæmolytic disease of the new-born, and in cases of acute acquired hæmolytic anæmia.

There is complete agreement between the two facets of activity of this factor, which appears to act on some locus of the red cells, the removal of which apparently allows the incomplete antibody to form a further link. It is not a normal second stage of the agglutination reaction, but it may help to give some explanation of this In the Coombs' test, the agglutination of sensitized cells does not appear to depend on a specific human globulin group, as Simmonds[8] has shown that other mammalian precipitin sera act equally well. There is not, however, agreement in the loss of virus receptors and the panagglutinating property, as Burnet has found that Freidenreich's panagglutinating strain *M* does not cause loss of virus receptors, and a partially purified α-toxin of *Cl. Welchii* Type *A*, though removing virus receptors, does not show panagglutinating properties.

It is not suggested that this test has any real advantages over the Coombs' and human albumin tests for the routine detection of incomplete anti-*Rh* antibodies, but it may help to show the mechanism of agglutination of immune hæmagglutinins and the relationship of the agglutinating to the blocking forms. Further work on the reactions from this point of view is proceeding.

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Influence of Heteroauxin on the Cotyledons of *Phaseolus vulgaris* L.

BY smearing cotyledon buds of *Phaseolus vulgaris* (var. non plus ultra) sprouts with heteroauxin paste ($C_{20}H_{18}O_{11}N_2$ + lanolin) so that the cotyledon stalks also come into contact with it, we obtain a prolongation of life of these stalks, which grow longer and larger and remain fresh green, while the rest of the cotyledons afterwards shrivel and change colour (Fig. 1).

This is a similar phenomenon to that observed by May[1] with the leaf stalks of *Coleus* and other plants by addition of pollen auxin, after removal of their lamina.

On the contrary, plants which were treated with lanolin only and untreated plants did not show the above-mentioned results.

In order to observe exactly the influence of heteroauxin on bean cotyledons, experiments were made on these organs of *Phaseolus vulgaris* cultivated in daylight on wet filter-paper, after they had been isolated by breaking or cutting off and smeared partly with heteroauxin paste and partly only with lanolin or untreated for the purpose of control.

The consequence was the formation of calluses which appeared in the three different cases in the following percentages: 98·3 per cent on the

Fig. 1. EFFECT OF HETEROAUXIN ON COTYLEDON STALKS

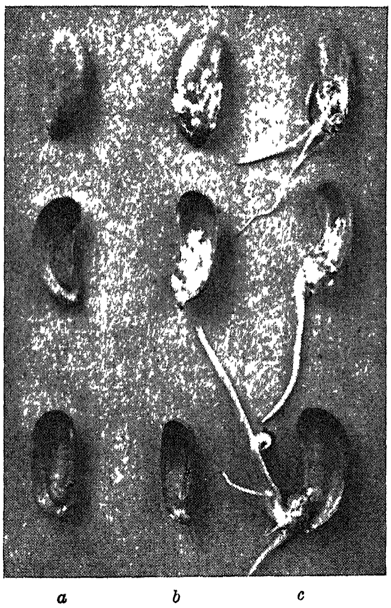

Fig. 2. ISOLATED COTYLEDONS: *a*, CONTROLS, *b*, TREATED WITH LANOLIN, *c*, TREATED WITH HETEROAUXIN, SHOWING BIGGEST CALLUSES AND SPROUTING OF ROOTS

h (heteroauxin) cotyledons; 88·1 per cent on the *l* (lanolin); 85·5 per cent on the untreated *c* cotyledons (control). But the heteroauxin not only increased the growth of the calluses, it accelerated also their development: 66·8 per cent of the *h* cotyledons formed calluses earlier than the *l* cotyledons; 78·9 per cent of the *h* cotyledons formed calluses earlier than the *c* cotyledons; 33·3 per cent of the *l* cotyledons formed calluses earlier than the *c* cotyledons.

The biggest calluses (size of a pea) were found exclusively on the *h* cotyledons (Fig. 2). Also the sprouting of roots was much stronger on the *h* cotyledons (47·1 per cent) than on the *l* cotyledons (3·2 per cent) and the control cotyledons (2·6 per cent) (Fig. 2).

The cotyledons smeared with heteroauxin were for a longer time turgid and appeared in a better state than all the others of the same age.

The conclusion from these observations is that the use of heteroauxin on isolated bean cotyledons causes a considerable prolongation of life and a growth in size as well as a remarkable increment in the development of callus tissue and roots

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Sphacelial Stage in the Life-history of *Claviceps purpurea* (Fr.) Tul.

IN a previous communication my associate and I[1] recorded for the first time successful artificial production of ergot sclerotia of high alkaloid content (total alkaloid content 0·32 per cent, ergometrine content 0·07 per cent) in the tropical plains of Bengal. Ergot, it may be stated here, has long been known to grow naturally at high altitudes and under temperate conditions of such countries as Spain, Portugal, Baltic States, etc. Reports of the artificial production of ergot sclerotia in situations akin to their natural habitats are known from Australia[2] and at Nilgiri Hills, Madras (India)[3].

While attempts in Australia[2] are meeting with indifferent results from year to year, our investigations here for the last two years are giving constant results and yield of high alkaloid contents.

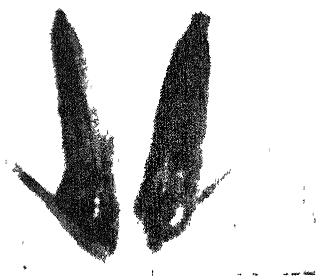

Fig. 1. SCLEROTIA SHOWING 'HONEY DEW' AT BASE NATURAL SIZE

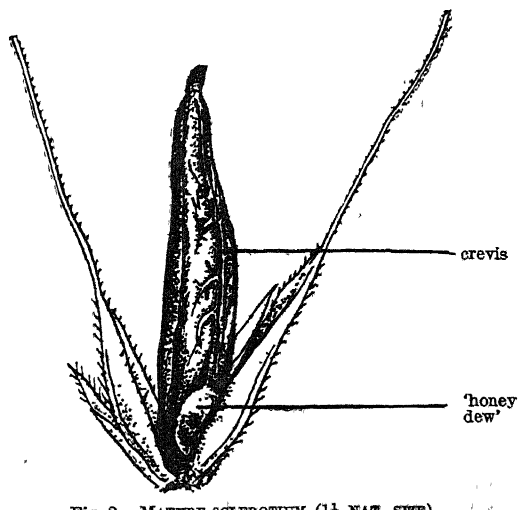

Fig. 2. MATURE SCLEROTIUM (1½ NAT. SIZE)

The following are some hitherto unrecorded observations on the ergot fungus (*Claviceps purpurea* (Fr.) Tul.) under tropical conditions of its growth.

(1) The sphacelial phase of the fungus did not end with the usual 'honey-dew' stage after a period of a week or two of the initiation of the sclerotium formation, but continued up to the time of its (sclerotium) harvest in the crevices on the sides of sclerotium near its base (Figs. 1 and 2). Small drops of 'honey' containing the sphacelial (conidial) spores were observed on the crevices near the base of the sclerotium partly enclosed under the covers of the glumes. This should be termed the secondary sphacelial stage. The spores of this secondary sphacelial stage were akin in all respects, including their viability, with those of the primary sphacelial stage.

(2) Sclerotia, apparently air-dried at the time of harvest, when stored in laboratory without additional sunning in not thoroughly dry glass-stoppered bottles, were soon found to be covered with a white downy growth. These growths, when examined under the microscope, were found to consist mainly of conidial spores of *Claviceps purpurea* (Fr.) Tul, together with a few mycelia. These conidial spores are more lanky than those of the 'honey dew' stage.

It appears that high humidity and high temperature favour continued production of conidial spores and so the continuation of the sphacelial stage.

The average monthly figures for minimum and maximum temperatures and humidity percentage for the period under observation are given in the accompanying table.

Period 1946	Temperature		Humidity		
	Min. ° F.	Max. ° F.	8 hr. I S.T. %	12.30 hr. I S T. %	17 hr. I S.T * %
January	54·4	80 6	79·8	34·6	42 1
February	63·8	90·1	85·1	37 1	40 7
March	70·5	93 9	70·3	30 5	36·5
April	73·9	91·9	82·5	55 2	63 2

* I.S.T. (Indian standard time) is 5 hr. 30 min. behind Greenwich mean time.

I wish to express my thanks to the Adair, Dutt Research Fund Committee, Calcutta, for providing a research scholar, and to Prof. J. C. Sen Gupta and Prof. G. P. Mazumdar for assistance.

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Bud-rot of Areca Palms and 'Hidimundige' in Mysore

DR. M. J. THIRUMALACHAR's note[1] on bud rot of areca palms in Mysore is interesting; but is likely to add to the confusion in the literature of bud-rot. Nowell[2] was careful to separate red ring disease of coconuts from bud-rot. Bud-rot in the eastern tropics, hitherto fortunately never confused with eelworm attack, is due to *Phytophthora*, and in Mysore, Dr. L. C. Coleman[3] and I[4] have found that the fungus produces bud-rot of areca palms. Bud-rot of palms has also been ascribed to *Bacillus coli*. It is only secondary in red ring.

The 'Hirethota' disease of areca palms differs in almost every respect from red ring of coco-nuts, as seen below.

Hirethota disease	Red ring disease
1. No yellowing or wilting of pinnæ	Yellowing and wilting of pinnæ
2. Green nuts not shed.	Green nuts in all stages of immaturity shed
3 Leaves shed, bud and crown rot, leaving bare stem.	Leaves not shed, crown not involved in rot
4 Nema present in vessels of vascular bundles.	Infestation confined to the ground tissue, vascular bundles unaffected in any way.
5. Spread of disease slow, extending over several years	Rapidity of infestation, in 60–70 days.
6 No red ring in stem	Red ring present in stem
7 Copious flow of evil-smelling liquid containing nema	No ooze.

In spite of the absence of the red ring, the most characteristic symptom, Dr. Thirumalachar identifies the disease with red ring on the plea that it might be symptomatic of the particular host.

In citing references, Dr. Thirumalachar has allowed several inaccuracies to creep in. He says that Nowell and Briton-Jones pointed out the untenability of Johnston's conclusion that bud-rot of coco-nuts is caused by *Bacillus coli*. Briton-Jones alone did that. He attributes to Nowell what Briton-Jones says about various modes of spread of the disease by fauna frequenting the crowns of coco-nut palms. Because seedlings distributed from Hirethota are reported to have transmitted the disease, he accepts what Nowell only conjectured, that fallen nuts may harbour the worms, and concludes that the disease is infectious and is possibly transported by some fauna. The disease is common on old trees, about ten years of age, and is rare on young palms, and to suggest that it occurs at that stage owing to transmission by the seedling is a little far-fetched. According to Nowell[2], "the rapidity of infestation shown in the infection experiments renders untenable the hypothesis first put forward that infection takes place at an early age without its effects becoming outwardly visible until the tree matures". 'Hidimundige' is present in very widely separated localities where there is no suspicion of its having spread from one centre. Dr. Thirumalachar states that red wing was first described from the British East Indies by Nowell, which is obviously a mistake. In the next sentence, however, he refers to its distribution in the western hemisphere.

Some work has been done in this department on the 'hidimundige' of areca palms. The tops of diseased trees show an internal injury in the crown in the form of a longitudinal cut extending from the top of the stem to a greater portion of the bud, with no outside injury. The inflorescences are attacked even as they are formed, and decay. Affected trees never bear fruit. The crowns dry up within about six to eight months of the attack, and in the affected tissues a saprophytic *Fusarium* and some bacteria occur. In some of the affected palms from Hirethota I noticed an enchytræid worm, but was not sure if it was pathogenic.

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DOUBLE VELOCITY CORRELATION FUNCTION IN TURBULENT MOTION*

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SINCE 1941 there have been three independently proposed developments in the theory of turbulent motion leading to substantially the same results. The most important of these common results is that as the Reynolds number of homogeneous isotropic turbulence increases indefinitely, the coefficient of correlation between parallel velocity fluctuations at two points distance r apart approaches the form $1 - Ar^{2/3}$ (A = const.), provided r is small compared with the integral scale of turbulence (L). This result was obtained (1) by A. N. Kolmogoroff in 1941, publication in *C.R. (Doklady) Acad. Sci. de l'U.R.S.S.*, (2) by L. Onsager in 1945, publication (in abstract) in the *Physical Review*, and (3) by C. F. v. Weizsäcker, in collaboration with W. Heisenberg, in 1946, as yet unpublished. The purpose of this short note is to direct attention to these results, since none of the authors is at the present Congress.

The three theories have certain elements in common, sometimes explicit and in some cases implied. These are: (1) the assumption of indefinitely high Reynolds' number of the flow as a whole; (2) the related assumption that the effect of viscosity on velocity correlations is negligible; this is not valid in the immediate neighbourhood of $r = 0$ where the double velocity correlation is parabolic, but this region becomes vanishingly small as the Reynolds' number increases; (3) the energy which can be imagined to be associated with a small range of wave numbers is received chiefly from wave numbers one order smaller (that is, eddies of larger size), and in turn passes on to larger wave numbers without loss through viscous dissipation; (4) the motion of the smallest existing eddies (of vanishingly small diameter) is entirely laminar and is responsible for most of the energy dissipation of the turbulent motion. These points are part of a physical picture of the turbulence which is roughly identical in the three theories. However, the mathematical formulations vary considerably.

The neatest and most powerful formulation of the physical ideas is that of Kolmogoroff. In order to be able to isolate the statistical effect of eddies of a certain range of sizes, Kolmogoroff first constructs a kinematical theory of correlations between the *differences* of parallel velocity fluctuations at two points. He supposes that the motion due to all eddies smaller than some suitable limiting size is isotropic, irrespective of the nature of the mean flow, and also statistically steady. This limitation of the size of the eddies considered is fundamental, and the limitation is achieved mathematically by restricting the distance r between the two points on which the velocity differences are based. Kolmogoroff next puts forward two similarity hypotheses, suggested by the physical picture of the turbulence at high Reynolds' numbers, from which the statistical characteristics of the motion due to these eddies can be deduced. The first asserts that the statistical characteristics depend only on the two quantities, viscosity (ν) and mean energy dissipation per unit mass of the fluid (ε). The second asserts that the statistical characteristics of the motion due to the larger of the eddies contained within the limit mentioned above depend only on one of these quantities, namely, the energy dissipation (ε).

Using dimensional considerations, it is then possible to construct the general form of the various correlations between velocity differences. The second similarity hypothesis leads, in the case of homogeneous turbulence, to the result mentioned above, that the double (parallel) velocity correlation coefficient varies as $1 - Ar^{2/3}$ for $\eta \ll r \ll L$, where η is a measure of the size of the smallest existing eddies; for guidance in the proof, note first that A has dimensions (length)$^{-2/3}$, that is, (velocity)$^{-2}$ $\times$ (energy dissipation per unit mass)$^{2/3}$, and secondly, that the similarity hypotheses apply to the velocity correlations themselves, and not to the coefficients. There are very few correlation measurements at high Reynolds' number with which this theoretical prediction can be compared, but there are other predictions from Kolmogoroff's similarity hypotheses which clearly have the correct form. One prediction not hitherto compared with experiment is that the skewness factor, formed from the second and third moments, of the probability distribution of the rate of extension in any direction is a universal constant. Measurements which confirm this prediction have been made at Cambridge; details are contained in a paper presented to this Congress.

The approach of Onsager is very different. This author represents the spatial distribution of velocity in isotropic turbulence by a three-dimensional Fourier series, that is, the motion is divided up among a number of wave-lengths. From the equations of motion he then finds an expression for the rate at which energy is transferred from one wave-length to another. This expression is such as to suggest the 'cascade' process whereby the energy movement from any wave-length is chiefly to neighbouring shorter wave-lengths, and eventually to the smallest wave-lengths where the motion is laminar. In the limit of very high Reynolds' number, the amount of energy received by any wave-length (which is neither very small nor very large) per second is equal to the amount passed on, and the amount of energy lost by all wave-lengths larger than l, say, is independent of l. On the basis of these notions, Onsager constructs an expression for the work done against Reynolds' stresses by the eddies of characteristic size larger than the wave-length l and equates it to a constant, namely, the total energy dissipation. This gives a definite wave-length distribution of energy, and on making a Fourier transformation the correlation law quoted above is obtained. The analysis is similar to that suggested by Dryden some years ago, with the exception that the net loss of energy is assumed to be negligible for all except the largest eddies, in which most of the turbulent energy resides. Dr. Onsager was kind enough to show me an account of his work, and I understand it will shortly be published in full.

The next step in this remarkable series of coincidences was taken by C. F. v. Weizsäcker and W. Heisenberg, who showed their unpublished manuscripts to Sir Geoffrey Taylor early in 1946. The physical picture of turbulent motion at high Reynolds' number put forward by Weizsacker is identical with that of Kolmogoroff, and his method of analysis is not wholly dissimilar. In order to be able to describe the motion due to eddies within a small range of sizes, Weizsäcker divides the region of

* A contribution to the Turbulence Symposium at the Sixth International Congress for Applied Mechanics held in Paris during September 22–29.

isotropic turbulence into a number of cubes. Each of these cubes is again divided into a certain integral number of cubes, and so on, with a constant ratio between the sizes of cubes of neighbouring order The characteristic velocity of eddies of dimensions L_n is then given by v_n, the root-mean-square of the velocity of fluid within the cube of side L_n relative to that within the cube of next larger size (L_{n-1}) containing the cube L_n. On dimensional grounds the work done against Reynolds' stresses created by the turbulent motion of cubes of side L_n is written as proportional to v_n^3/L_n. This represents the rate of energy loss of all eddies larger than L_n and, in virtue of the assumption that viscous dissipation losses are confined to the smallest eddies, must be independent of n. The energy associated with the cubes of side L_n is then proportional to $L_n^{2/3}$, and the energy per unit wave-number (k) is proportional to $k^{-5/3}$; the now familiar double velocity correlation function is obtained from a Fourier transformation. Heisenberg has repeated Weizsacker's analysis in terms of Fourier series, and has extended it to obtain other results of interest, which will probably be described in a German publication. He finds a moderately good agreement between the theoretical spectrum law and measurements made by Simmons.

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RECENT MARINE BIOLOGICAL RESEARCH

THE recent volume of the *Journal of the Marine Biological Association** is of normal size and quality and is a reminder that once again we can pursue and enjoy knowledge for its own sake.

Prof. A. C. Hardy contributes a moving tribute to a great leader in his obituary notice of Dr. Stanley Kemp, the director of the Marine Laboratory at Plymouth. Every zoologist should read it; to his friends it will bring happy memories of Dr. Kemp's enthusiasm, energy, modesty and whole-hearted devotion to his subject, and to those who had not the privilege of knowing him an example and an inspiration. Dr. Kemp fully maintained the tradition of the Plymouth Laboratory, initiated by the late Dr. E. J. Allen on the lines of Anton Dohrn's Laboratory at Naples, of interesting himself directly in the widely different fields of research being followed by the permanent and visiting workers at the Laboratory. Mr. D. P. Wilson adds a graphic account of the night of the raid (March 20, 1941) when Dr. Kemp lost his home and all his possessions, including his collection of antique furniture, his books, and all the material and manuscript notes of a work on the "Discovery" deep-water decapod Crustacea. The Laboratory was damaged by high explosive; but the fire from Dr. Kemp's house was prevented from spreading, and before the ashes had cooled, he was planning for the future. Yet who can doubt that the strain of that night undermined his strength. We are indebted to Dr. J. H. Welsh, of Harvard University, for the excellent photograph of Dr. Kemp which forms the frontispiece of the volume.

The scientific contributions fall into four groups: phytoplankton, biochemistry, zoology and fisheries.

Phytoplankton. Mr. D. P. Wilson describes triradiate and other forms in *Nitzschia closterium*, using sub-cultures from the thirty-six year old stock founded by Allen and Nelson in 1910. All these forms may pass into one another by division, but the preponderance of the larger types may be detrimental when minute larvæ have to be fed.

Mr. R. S. Wimpenny examines the varieties of *Rhizosolenia styliformis* and considers that this cosmopolitan species has three forms, which he calls *longispina* (the type of the species), *oceanica* and *semispina*.

Biochemistry. Mr. S. P. Chu studied the utilization by phytoplankton of organic phosphorus. Only dissolved phosphorus can be used directly by plants, and so little is known of the phosphorus cycle in the sea that it was assumed that only phosphate could be absorbed by marine plants. Diatoms can utilize inorganic orthophosphate in solution, but Chu found that though pyrophosphate cannot be used as effectively as orthophosphate, phytin was more successful, and organic forms of phosphorus can be broken down by diatoms and used directly. It is thus possible to construct a phosphorus cycle on the same lines as the nitrogen cycle for living beings in the sea.

Zoology. Dr. Vera Fretter adds another paper to her series on the combined anatomy, histology and physiology of molluscs by a study of the genital ducts of *Theodoxus*, *Lamellaria* and *Trivia*, with a discussion of their evolution in prosobranchs.

Mr. H. G. Q. Rowett contributes a paper on the feeding mechanisms of the nudibranch *Calma glaucoides* and the crustacean *Nebaliopsis typica.* The former is known to feed on the eggs of various shore-living fishes; the latter, a deep-sea form, has not been seen feeding, but its gut contents are of a rich yolky nature, and it is therefore suspected of taking fish eggs from the sea bottom. In *Calma*, the radula and jaws nip the egg membrane and suck its contents, but in *Nebaliopsis* the egg must be taken past the weak mandibles into the tough œsophagus, and there split and sucked. Thus two widely separated animals have evolved feeding arrangements which are similar in plan.

Prof. C. M. Yonge has three papers in this volume, two on the habits of the lamellibranch *Aloidis (Corbula) gibba* and the gastropod *Turritella communis* respectively, and the third on the membranes surrounding the eggs of *Homarus vulgaris*. *Aloidis* anchors itself by a single byssus thread to a gravel stone on a coarse mud bottom, burrowing until only the short siphons are protruded. Ciliary currents collect debris, bacteria and diatoms, mixed with considerable quantities of inorganic matter, the last expelled forcibly as pseudo-fæces by means of a

* *Journal of the Marine Biological Association of the United Kingdom*, **26**, No. 3, 1946 (Cambridge University Press). 25*s*.

quick-acting portion of the adductor muscles. Even the foot can be pushed through the inhalant aperture to clear the sediment.

Another bottom feeder is *Turritella communis*. Graham (1938) described its method of ciliary feeding, and the formation, unique among Prosobranchs, of a siphon formed by two folds of the body wall, and used for the expulsion of fæces. Yonge found that the mollusc burrows diagonally into thick muddy gravel, then with its foot pushes the mud away from the left side of the head, making an inhalant depression. The displaced mud accumulates in a small mound which piles up in front of the head and is agglutinated by secretion of the pedal gland. Head and foot are then withdrawn below the surface, water and small organisms are drawn in by ciliary action into the left side of the mantle cavity, and water and fæces expelled on the right through the 'siphon'.

Dr. Lebour clears up the confusion which existed regarding the species of *Teredo* from Plymouth waters by a careful study of living material. She describes three species, *T. norvegica* and *navalis* from the experimental raft moored near Plymouth Breakwater, and *T. megotara* occurring occasionally in driftwood. Development within a brood pouch takes place in *T. navalis* only.

Mr. D. W. Ewer describes a variety of *Sabella pavonina* from Plymouth, previously named by Hornell (1891) *S. pavonina*, var. *bicoronata*, from Hilbre Island, near Liverpool. In this variety the number of filaments on the two sides of the branchial crown is unequal. Since inequality in the number of filaments in *Spirographis* was the only positive character distinguishing it from *Sabella*, that distinction is no longer valid, and both should be united under *Sabella*, as re-defined.

Mr. D. P. Wilson's photographs of living marine animals are well known, and to this series he adds an excellent set of *Sepia officinalis* stalking, capturing and consuming a prawn. The action of the tentacles in gripping the prey is shown, and of great interest are the colour changes in the skin. *Sepia* blushes when in pursuit, but pales when the prey is caught and transferred to the mouth.

Fisheries. Mr. E. Ford discusses vertebral variation in isospondylous fishes. This is Part 3 of his series on this subject, and includes the families Clupeidæ, Salmonidæ and Argentinidæ. He directs attention to the diagnostic value of vertebral counts, to the siting of other structures relative to the backbone elements, and to the marker characters which provide the means of recognition on sight.

Two papers by Mr. C. F. Hickling deal with haddock and herring fishing. He studied the self-contained stock of haddock on the Porcupine Bank, off the west coast of Ireland. The Bank had complete immunity from trawling, owing to the War, from 1940 until 1944, with the result that it now carries "the densest stock of haddock ever experienced there". There was no evidence that overcrowding had slowed the rate of growth.

The herring fisheries carried on from Milford Haven provide herrings nearly all the year round. There are a winter and spring drift net fisheries, and summer and autumn trawl fisheries. As evidence indicates that all are based on the same stock of herrings, this area should provide "a fruitful field of work for the study of the seasonal cycle of the herring".

N. B. Eales

PLANT VIRUSES

SEVERAL recent papers from the Department of Plant Pathology, Rothamsted, and from the Council for Scientific and Industrial Research of Australia, make an impressive collection of new knowledge about virus diseases of plants. F. C. Bawden and N. W. Pirie[1] show that sap expressed from the leaves of tobacco plants infected with mosaic contains less than one third of the total amount of virus in the plant. The additional virus can be liberated by successive incubations with commercial trypsin, or, even more successfully, with the mixture of enzymes obtained from crops of the snail *Helix aspersa* Subsequent fine grinding releases even more virus, which was found to account in all for one third of the total insoluble nitrogen in the leaf, or 10 per cent of its dry matter. J. B. Hale, M. A. Watson and R. Hull[2] discuss "some causes of chlorosis and necrosis of sugar-beet foliage". They describe the symptoms and characteristics of two viruses, one fungus disease and four nutritional disorders of the crop, combining analytical and pathological methods with field experiments. Sugar-beet yellows and manganese deficiency can be distinguished visually, according to the authors, but a little more clarity of comparison would be welcome. The paper is, however, a vigorous attempt to place the field recognition of sugar-beet diseases on a surer basis than hitherto, but still leaves the impression that the advisory pathologist requires the backing of chemist and virus etiologist. A new species of shallot aphis, *Myzus ascalonicus*, is described by J. P. Doncaster and B. Kassanis[3]. The aphid resembles *Myzus persicæ*, and is also a vector of plant viruses. Both the species transmit cucumber virus I, *Hyoscyamus* virus III and sugar-beet yellows virus. *M. ascalonicus* transmits dandelion yellow mosaic, whereas *M. persicæ* does not, though the latter aphid transmits potato *Y* virus, lettuce and sugar-beet mosaics, and severe etch virus, for which *M. ascalonicus* is not a vector. Here is further knowledge for use in virus analysis.

Potato varieties differ considerably in their susceptibility to insect transmission of virus *Y* [4]. The American variety Katahdin was found to be most resistant, while Majestic and Arran Banner were the hardest of British varieties to infect. Ulster Monarch was the most susceptible variety investigated. The concentration of virus varied in different varieties. E. M. Hutton, working in Australia[5], approaches the question of resistance to virus *Y* from the genetic angle. He has isolated fifteen phenotypes which are hypersensitive to the virus. They produce varying degrees of necrosis, following mechanical inoculation with virus *Y*. The variety Katahdin is here a source of hypersensitivity, and it seems necessary for more research to be performed, in order to link the English and Australian findings; methods of inoculation are not the same, and this may provide an explanation. J. G. Bald and C. E. W. Oldaker[6] describe the reactions of the varieties Brownell and Silverskin Bismark to viruses *A*, *X*, *Y* and leaf-roll. Brownell is a carrier of virus *X*, is immune to virus *A* in the field, and is susceptible to leaf-roll. Bismark is resistant to leaf-roll, but is susceptible to a 'crinkle' caused by a combination of viruses *X* and *A*. The old Australian potato variety, Brown's River, has yielded a virus now identified by J. G. Bald and D. O. Norris[7] as virus *C*. It has many properties similar to virus *Y*, but is not readily transmitted by *Myzus persicæ*, the main vector of virus *Y*. J. G.

Bald[8] also finds that potato rugose mosaic (viruses $X+Y$) reduces the yield to about 50 per cent that of healthy plants, and the reduction is proportional to the diminution of leaf area caused by the disease.

The economic significance and complex nature of the virus problem make it one of the major challenges to modern biological investigation. A patient amassing of the facts, as typified by the eight papers here reviewed, is manifestly the only sure way of approach, and it is not until this is accomplished on a wide scale that any great practical results can be expected.

JOHN GRAINGER

[1] *Brit. J. Exp. Path*, 27, 81 (1946).
[2] *Ann App. Biol.*, 33, No 1, 13 (1946)
[3] *Ann. App. Biol.*, 33, No. 1, 66 (1946).
[4] Bawden, F C., and Kassanis, B., *Ann. App. Biol*, 33, No. 1, 46 (1946).
[5] *J Coun. Sci and Ind. Res.*, 18, No. 3, 219 (1945).
[6] *J. Coun Sci. and Ind Res*, 18, No. 3, 209 (1945).
[7] *Phytopath.*, 35, No. 8, 591 (1945)
[8] *Phytopath.*, 35, No 8, 585 (1945).

BANANA LEAF SPOT

THE leaf spot disease of bananas, caused by *Mycosphærella musicola* Leach (*Cercospora musæ* Zimm.), long known as a destructive malady in the Australasian region, was not observed in the New World until 1934, when a small outbreak was observed in Trinidad. This was soon followed by news of the disease in Suriname, Jamaica and Central America, and the Caribbean region generally. In the course of the few years during which the disease waxed to epidemic proportions it was under constant observation. Hence it may fairly be claimed that among plant epidemics the leaf disease of bananas is among the most fully documented and best known scientifically. The progress of the disease has been marked by a number of important advances in our knowledge, such as the details of infection, the progressive development of symptoms in plantations, and the ultimate effects of the disease on commercial fruit intended for refrigerated transport overseas. Not least important, as a result of imaginative innovations on a gigantic scale, the large fruit companies operating in Central America showed how the disease could be controlled by frequent spraying with appropriate fungicides.

The Colony of Jamaica, with its many and varied types of banana plantation, large and small, on hill-side and plain, presented special difficulties in the matter of disease control. It was realized that further investigations both of a fundamental and applied character were necessary if rational control measures were to be forthcoming. To this end Mr. R. Leach was appointed as mycologist for the investigation of leaf disease. His report, the result of four years of work, is now before us (R. Leach, "Banana Leaf Spot", Dept. Agric. Jamaica, Govt. Printer, Kingston, pp. 118, illustrated, 2*s*.). This work, largely based on direct field studies of the pathogen, covers a great deal of new and interesting ground and can only be dealt with summarily here. What, in brief, Leach set out to do was to obtain, by direct observation and experiment, a comprehensive knowledge of the main features of the disease on which basic principles of control could be developed. In the course of these studies, not only was the ascigerous stage of the pathogen discovered, but also it was found that there were differences in symptoms between ascospore and conidial infections; and that a peculiar relationship existed between soil conditions and the type of fructification produced in the leaf spots Certain soil conditions, which affect the metabolism of the leaves, are attended by the development of an abnormally large number of perithecia throughout the year, ascospore infection being reduced only during the colder months. The adverse soil factors include poor aeration, marked fluctuations in the oxidation/reduction conditions, and shallow tilth layers. Hence the importance, particularly in Jamaica, of measures designed to conserve fertility by attention to drainage, maintenance of soil structure, etc.

The details of spot development, and their distribution on the leaf surface; the development, dissemination, germination and viability of spores; the factors affecting infection; the principles of control by spraying; the seasonal variation in disease intensity; and other matters have been the subject of close observation and experiment, the whole constituting a substantial body of fact and a real contribution to our knowledge of this important disease. Mr. Leach and the Jamaica Department of Agriculture are to be congratulated on having carried through to a successful conclusion this difficult and comprehensive series of investigations.

C. W. WARDLAW

FORESTRY IN UGANDA

IN the annual report of the Uganda Forestry Department for the year 1945 (Government Printer, Uganda, 1946), the objectives of the forest policy are laid down: first, to reserve in the State sufficient land either already under forest or capable of afforestation to maintain climatic conditions suitable to agriculture; to preserve water supplies; to provide forest produce for the agricultural industrial development, and to maintain soil stability in areas where the land is liable to deterioration if put to other uses; secondly, to manage the forest property of the State to the best financial returns, such as are consistent with the primary aims set out above; to encourage and assist the practice and science of forestry by native authorities, and private enterprise; and lastly, to foster by education and propaganda a real understanding among the people of Uganda of the value of forests to them and to posterity, and to educate selected Africans in technical forestry.

These objects and ambitions have been enumerated in one form or another in the British Empire ever since the Indian Forest Service was formed more than eighty years ago. In many parts of the Empire, however, extraordinarily little progress has been made, and by its unchecked utilization of available timber supplies both in and outside the Empire, which the late War necessitated, the attainment of these objectives might seem to be farther off than ever. But the institution of conservation boards in connexion with agriculture and forestry in many parts of the world gives hope that at length the policy so well outlined above, which practically covers the whole of the aims and objects of forestry, will be given effect to; and above all that the close inter-relation between forestry and agriculture will at length be given some measure of recognition in Africa, both West and East.

It is a credit to Uganda that its Forestry Department is among the first to write and publish effective working plans for some of its forest areas. Local plans produced for local areas but not made public afford little information as to the progress being made by a forestry department. As a last resort, professional progress of any standard is made manifest by means of a printed and published working plan, and in this Uganda has apparently taken a lead.

FORTHCOMING EVENTS

Monday, December 16

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting, at 6.30 p.m.—Miss H. M. Bruce: "The Assay of Anti-Thyroid Substances using Tadpoles"; Mr. E. C. Wood: "The Computation of Microbiological Assays of Amino-Acids and other Growth Factors".

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. J. M. Buist and Dr. D. A. Harper: "The Revision of British Standard Specifications for Vulcanised Rubber".

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS (at the Royal Victoria Hotel, Sheffield), at 6.15 p.m.—Dr. Hugh O'Neill: "Some Recent Problems for Railway Metallurgists".

CHEMICAL SOCIETY, LEEDS BRANCH (in the Chemistry Lecture Theatre, The University, Leeds), at 6.30 p.m.—Prof. Harold C. Urey: "Isotopes".

Tuesday, December 17

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Rt. Hon. Lord Elton: "The Work of the Rhodes Trust".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. W. B. Douglas: "Social and Economic Problems of Childbearing in Britain—Report of a Questionnaire Inquiry".

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (in Room 87, The Polytechnic, 309 Regent Street, London, W.1), at 5.30 p.m.—Prof. W. V. Mayneord: "Applications of Nuclear Physics in Medicine".

SHEFFIELD METALLURGICAL ASSOCIATION (at the Metallurgical Club, 198 West Street, Sheffield), at 6.30 p.m.—Dr. J. White: "The Physical Chemistry of Steelmaking Reactions".

SOCIETY OF DYERS AND COLOURISTS, HUDDERSFIELD SECTION (at Field's Café, Huddersfield), at 7.30 p.m.—Mr. A. Klinger: "A Survey of Continental Finishing".

Wednesday, December 18

INSTITUTE OF FUEL, YORKSHIRE SECTION (at the University, Leeds), at 2.30 p.m.—Dr. C. C. Hall: "Fischer-Tropsch Process—Present and Future".

CHEMICAL SOCIETY, NEWCASTLE-UPON-TYNE SECTION (joint meeting with the local sections of the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY, the INSTITUTE OF CHEMICAL ENGINEERS and the COKE OVEN MANAGERS' ASSOCIATION, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Dr. H. C. Craggs and Mr. H. M. Arnold: "Hydrogen Sulphide Removal by Ammoniacal Ferrocyanide Liquors".

CHEMICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 7.30 p.m.—Prof. Harold C. Urey: "Some Problems in the Separation of Isotopes" (Eleventh Liversidge Lecture).

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—"The New Place of Science in Higher Education" (Speakers: Sir J. E. Lennard-Jones, F.R.S., Prof. R. V. Southwell, F.R.S., Mr. J. T. Saunders and Sir Thomas Merton, F.R.S.).

Thursday, December 19

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 3.30 p.m.—Discussion on the "Report of Defective Colour Vision in Industry" (to be opened by Dr. A. H. Gale, Mr. R. F. G. Holness, Dr. J. Sharp Grant, Prof. L. C. Martin and Dr. M. Abrahamson).

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. W. David Evans: "The Geology and Opencast Mining of the Jurassic Ironstones of Great Britain"; Mr. N. W. Wilson: "Notes on the Estimation of Tonnage and Grade of some Chromite Dumps".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Symposium on "The Geometry of Numbers" (arranged by Prof. H. Davenport, F.R.S.).

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. John Wishart: "Statistical Aspects of Demobilization in the Royal Navy".

CHEMICAL SOCIETY, SOCIETY OF CHEMICAL INDUSTRY and ROYAL INSTITUTE OF CHEMISTRY, EDINBURGH AND EAST OF SCOTLAND SECTIONS (in the Biochemistry Lecture Theatre, the University, Teviot Place, Edinburgh), at 5.30 p.m.—Prof. Harold C. Urey: "Some Problems in the Separation of Isotopes" (Eleventh Liversidge Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting with the INSTITUTION OF MECHANICAL ENGINEERS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. H. Sparks: "The Future of Pulverized-Coal Firing in Great Britain".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. J. Smith: "The Evolution of the Spitfire".

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the Midland Hotel, Bradford), at 7 p.m.—Dr. A. B. Wildman: "The Microscopy of Fibres—Aids to their Identification".

Friday, December 20

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. A. Sykes: "Progress in Turbine Gear Manufacture in Recent Years"; Mr. Cecil Timms: "The Measurement of Errors in Gears for Turbine Reduction Drives".

INSTITUTE OF FUEL, SCOTTISH SECTION (at the Royal Technical College, Glasgow), at 5.45 p.m.—Dr. E. A. C. Chamberlain: "Some Aspects of Domestic Heating Appliances".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at St. Enoch Hotel, Glasgow), at 7 p.m.—Discussion on the Report of the Committee on "The Dyeing Properties of Direct Cotton Dyes" (to be introduced by Mr. John Boulton).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (man or woman) IN BIOLOGY—The Director of Education, Education Department, The Guildhall, Swansea (December 19).

SCIENTIFICALLY QUALIFIED OFFICER (temporary) in the Blood Transfusion Service in the North-West Region—The Regional Establishment Officer, Ministry of Health Regional Offices, Sunlight House, Quay Street, Manchester 3 (December 21).

ASSISTANT LECTURER IN ENGINEERING in the Bradford Technical College—The Director of Education, Town Hall, Bradford (December 21).

SCIENCE GRADUATE (Zoology) for bureau literary work—The Director, Imperial Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey (December 25).

ASSISTANT LECTURER IN MATHEMATICS, ASSISTANT LECTURER IN PHYSICS, and an ASSISTANT LECTURER IN CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (December 27).

PROFESSOR OF CIVIL ENGINEERING, PROFESSOR OF MECHANICAL ENGINEERING, and PROFESSOR OF ELECTRICAL ENGINEERING, at the Thomason College of Engineering, Roorkee, U.P., India—The Office of the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 290 (December 28).

ORGANIC CHEMIST at Long Ashton Research Station—The Secretary and Registrar, The University, Bristol 8 (December 28).

ASSISTANT LIBRARIAN in the Medical Department—The Director, Appointments Department, British Council, 3 Hanover Street, London, W.1 (December 28).

BIOLOGIST, and a JUNIOR ASSISTANT PHYSICIST, in the Biophysics Research Group, and a JUNIOR ASSISTANT PHYSICIST in the Clinical Physics Department—The Secretary, Mount Vernon Hospital and Radium Institute, Northwood, Middx. (December 28).

EXPERIMENTAL OFFICERS (with qualifications in (*a*) Mechanical Engineering, (*b*) Electrical Engineering including radio, or (*c*) Mathematics including preferably aerodynamics), for abstracting and indexing of scientific and technical papers and reports, and an ASSISTANT EXPERIMENTAL OFFICER to assist in a technical library, at the Guided Projectiles Establishment, Westcott, Berks.—The Director of Scientific and Technical Administration (D), Room 27, Ivybridge House, John Adam Street, Strand, London, W.C.2, quoting No. D.1/46 (December 28).

GENERAL SECRETARY—The Secretaries, Chemical Society, Burlington House, Piccadilly, London, W.1 (December 31).

SENIOR LECTURER or LECTURER IN BIOLOGY AND RURAL SCIENCE at the Burderop Park Emergency Training College for Men, Wroughton, Wilts.—The Director of Education, County Hall, Trowbridge, Wilts. (December 31).

RESEARCH ASSISTANT to take part in the Economic Survey of Northern Ireland and its relationship to the economy of Great Britain—The Secretary, Queen's University, Belfast (December 31).

LECTURER IN MINING, and a LECTURER IN ELECTRICAL ENGINEERING, at the Cannock Chase Mining College—The Director of Education (Dept. F.E.), County Education Offices, Stafford (January 1).

ASSISTANT CHIEF CHEMIST (Ref. F.1281.A), and a CHEMIST (Ref. F.1282.A), for large Oil Refinery in the South of England—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (January 4).

SENIOR POSTS (2) in the Television Section of Research Department—The Engineering Establishment Officer, British Broadcasting Corporation, Broadcasting House, London, W.1 (January 8).

LECTURER IN STATISTICS—The Secretary, The University, Aberdeen (January 15).

SENIOR LECTURER and a JUNIOR LECTURER IN ANIMAL HUSBANDRY at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (January 20).

LECTURER IN CHEMISTRY at Natal University College—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

ENTOMOLOGIST to carry out a survey of the tsetse areas of the Southern Sudan and undertake research work—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Veterinary Entomologist'.

BOTANIST to carry out a survey of the grazing areas of the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Pasture'.

LECTURER or ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Exeter.

ASSOCIATE PROFESSOR OF CHEMISTRY AND PHYSICS at the Royal College of Medicine, Baghdad, an EXPERT IN ENTOMOLOGY, an ENTOMOLOGIST, and a SOIL TECHNOLOGIST, to the Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M N.13724

FISH EXPERT by the Iraqi Government Ministry of Economic Affairs—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M N 14573.

SCIENTIFIC JOURNALIST—The Secretary, British Rubber Development Board, 19 Fenchurch Street, London, E.C.3

EDITORIAL ASSISTANT for the *Journal of the Institution of Electrical Engineers*, and an ASSISTANT LIBRARIAN (man)—The Secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2.

HORTICULTURAL INSTRUCTOR—The Principal, County Agricultural Institute, St Mary's Gate, Derby.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

University of London · University College Annual Report, February 1945–February 1946 Pp 60. (London: Taylor and Francis, Ltd., 1946) [126

Ministry of Fuel and Power and British Intelligence Objectives Sub-Committee Technical Report on the Ruhr Coalfield By a Mission from the Mechanisation Advisory Committee of the Ministry of Fuel and Power B I O S. Final Report No 394 Vol 1. Pp vi + 61 (London H M Stationery Office, 1946.) 3s net [126

Annals of the Solar Physics Observatory, Cambridge Vol 3, Part 3 The Distribution and Movements of Solar Prominence Areas By W. Moss, under the direction of H F. Newall, and subsequently of F. J. M. Stratton Pp vii + 119–128 + 7 plates. (Cambridge At the University Press, 1946) 5s net [126

Ordnance Survey. Booklet No 1/45. A Brief Description of the National Grid and Reference System Pp. 12. (London: H M Stationery Office, 1946) 4d net [136

British Drug Houses, Ltd Report of the Directors for the Year ended 31st December 1945. Pp 8. (London. British Drug Houses, Ltd, 1946) [136

International African Institute. Memorandum 21 · The Study of Africa's Past. By Thurstan Shaw. Pp 24. (London Oxford University Press, 1946.) 2s. net. [136

A Study of the Growth of Grass in 'Surface-Stabilised' Soil. By Martin A. F. Sutton, in collaboration with T. F. N. Alexander and F. C. West. Pp. 28. (Reading: Sutton and Sons, Ltd., 1946) 3s 6d net. [146

Department of Scientific and Industrial Research: Forest Products Research. A Handbook of Woodcutting. By P. Harris. Pp 44 (London: H M. Stationery Office, 1946.) 9d. net. [186

National Smoke Abatement Society. Sixteenth Annual Report, 1945. Pp. 20. (London. National Smoke Abatement Society, 1946.) [186

Royal Anthropological Institute. Report of the Council for the Session July 1945 to June 1946. Pp. 16. (London: Royal Anthropological Institute, 1946) [186

Ministry of Supply Some Properties and Applications of D.D.T. Pp. 36. (London. H.M. Stationery Office, 1946.) 6d. net. [186

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ETHICAL ASPECTS OF THE DEVELOPMENT OF ATOMIC ENERGY

TO promote an understanding of the aims of the United Nations Educational, Scientific and Cultural Organisation, the Chicago Section of the American Chemical Society arranged a banquet in connexion with the National Chemical Exposition at which the theme was the role of the scientific worker in promoting world peace. Dr. W. A. Noyes, jun., in a broadcast address, emphasized that, for peaceful progress, we cannot rely on the control of specific weapons, atomic or otherwise, because weapons themselves are not the cause of war. He appealed to chemists, who must bear their full share of responsibility for enabling war to be made more and more awful, to give their best support to the subsidiary organisations, such as the Educational, Scientific and Cultural Organisation, which are endeavouring to promote understanding between peoples and to make the world a better place in which to live. Dr. Noyes urged the importance of the objective of raising the level of scientific work throughout the world, and of eventually securing great scientific institutions in all countries. Indeed, his realistic address was in essence yet another plea for full freedom of scientific and cultural intercourse.

Dr. Noyes announced the appropriation by the American Chemical Society of 25,000 dollars to promote international understanding and goodwill by enabling foreign chemists and chemical engineers to pursue advanced study in the United States. Dr. T. H. Hogness in turn stressed the particular qualifications of the scientific worker which enable him to assist in promoting world peace, especially in undertaking certain phases of the task of educating public opinion, through his special knowledge and insight into the implications of scientific progress. The most interesting passage in Dr. Hogness's address is, however, his quotation from a report of scientific men transmitted on June 11, 1945, to the Secretary of War. The justification for the concern of men of science with political issues could not be better put than in this report, written before the atomic bomb was first used.

"The only reason to treat nuclear power differently from all the other developments in the field of physics is the possibility of its use as a means of political pressure in peace and sudden destruction in war. All present plans for the organisation of research, scientific and industrial development and publication in the field of nucleonics are conditioned by the political and military climate in which one expects those plans to be carried out. Therefore in making suggestions for the post-war organisation of nucleonics, a discussion of political problems cannot be avoided."

The report goes on to urge that the political problems arising from the mastering of nuclear power should be recognized in all their gravity, and that appropriate steps should be taken for their study and for the preparation of the necessary decisions. The existence of nuclear weapons is regarded as the most compelling argument calling for an efficient international organisation for peace. The quotation from the report shows that, before the world at large was aware of the dangers, the fundamental factual knowledge of men of science had led them to urge the governments concerned to take the appropriate measures to deal with the situation. Dr. Hogness points out that in such educational work, however, the man of science needs the assistance of such a movement as the United Nations Educational, Scientific and Cultural Organisation, and he adduces the international heritage and outlook of the man of science as a further qualification in promoting the organisation of peace.

Quoting appropriately from Edmund Burke's "Reflections on the Revolution in France" that "society is indeed a contract" and that the State "is not a partnership in things subservient only to the gross animal existence of a temporary and perishable nature ; it is a partnership in all science ; a partnership in all art ; a partnership in every virtue and in all perfection", Dr. Hogness concludes with the exhortation that the scientific worker's contract with society includes taking his place among those who are particularly qualified to give leadership in the great effort towards world peace; and there can be no doubt that, if U.N.E.S.C.O. is to achieve its real purpose of furthering international exchange and understanding, scientific men must make a very real contribution to its proceedings. Something of the realism they have already shown in dealing with the problem of atomic energy and its control will be required. The programme before the General Conference in Paris included more than seventy projects, some of which can scarcely be regarded as possessing the urgency of the restoration of education and cultural activities in the devastated countries.

It may well be that the most important contribution of the United Nations Educational, Scientific and Cultural Organisation to the solution of the problem of control of atomic energy will be in bringing about a more favourable 'climate' of political opinion. Meanwhile, it is interesting to note that, just as much in the report from which Dr. Hogness quotes has stood the test of the last eighteen months, so also much of Prof. Lewis Mumford's latest book, "Programme for Survival"*, written in August 1945, is as pertinent and relevant to-day as when it was written. Few readers will dissent from Mumford's comment in his preface that his conclusions would have been unchanged had he written in the spring of 1946. The book, in fact, is a continuation of the final chapters of "The Condition of Man", and is an urgent penetrating study of the tendencies now dominant in modern society, and an unmistakable warning as to the catastrophe they involve if unchecked.

Prof. Mumford urges that the vital question before us is whether mankind has imagination enough to mobilize, on behalf of peace and co-operation, forces that men have hitherto conscripted only for war and destruction. It is a question of dynamic will-power and time ; Prof. Mumford is as insistent as scientific men themselves that we have only a limited time in which to learn the art of control and to prevent the suicidal misuse of scientific knowledge. To do this is, in fact, to outlive the atomic age itself, the age of unqualified indiscriminate power, and it is at least encouraging to find in this book the recognition that we must be prepared, as part of the price of the safety and continued development of mankind, to scrap any part of the modern world. Preconceived ideas and political prejudices are in fact the gravest danger to which mankind is exposed, and nothing less than the same clear, fearless thinking at the political level, which in the scientific and technical field has placed at man's disposal nuclear energy, is likely to avert disaster.

Unconditional co-operation, Prof. Mumford holds, is the price of mankind's survival ; and he sets that as the objective, urgent and imperative, but not to be attained unilaterally or forthwith as Mr. Lionel Curtis is inclined to suggest. He makes, incidentally, a powerful case for some attempt to redress the lopsidedness of scientific advance : appropriations like those for the development of nuclear energy should be matched by commensurate appropriations for the promotion of the social knowledge and technique which would facilitate the control of such weapons. Advances in the human and social sciences must be kept more and more in step with advances in the physical sciences.

The first step toward control of atomic energy, Prof. Mumford agrees, must be an international one. No one country can establish adequate controls Moreover, military control must precede industrial exploitation : to foster the industrial uses of atomic energy and to widen the processes of creating it, without first establishing world government, is to cause chaos. He even argues that there is no pressing need for the rapid extension and exploitation of atomic energy for peaceful purposes. Here he parts company with the report of the Lilienthal Board, on which the proposals presented by Mr. Baruch to the Atomic Energy Commission are based, and states that he would be willing to urge the relinquishment of the use of atomic power for the next decade or so while we perfect the system of international control. From this point of view he argues quite logically that freedom of research, for the present, should not apply to this field, nor should the control of research be left even to the most responsible group of scientific workers. Prof. Mumford might thus be expected to approve the appointments made by President Truman for the Atomic Energy Commission : headed by Mr. David Lilienthal, supported by Mr. Robert Bacher, who was second in command of the Los Alamos Laboratory during the War, the members designated for the Commission are, with one exception, intelligent laymen rather than the scientific men and engineers who were concerned with the plants of the Manhattan Project.

Neither Dr. Hogness, Dr. Noyes, nor Mr. Lilienthal himself, who also addressed the American Chemical Society at Chicago, advocated that the scientific man as such should enter the political field. What they urged was the introduction of the fact-finding method of science into the political sphere as a step toward

* Programme for Survival. By Lewis Mumford. Pp. iv+67. (London : Martin Secker and Warburg, Ltd., 1946.) 3s. 6d. net.

the elucidation of policy and measures, and while Prof. Mumford points out, as Dr. A. MacLeish has done before him, that the reactions of the intellectual classes to the Second World War show how little their special discipline is to be trusted in the appraisal of realities, he finds in the response of the physical scientists to the human threat of their most significant single advance in science and technology one of the few encouraging signs in the present situation. His tribute to the capacity for personal re-integration which such men of science have shown in order to deal unreservedly with this emergency is generous and deserved; and the scientific world should not dismiss too lightly Prof. Mumford's pleas that at the moment the issue of freedom in nuclear research is not the decisive factor, and that the world can afford to wait a decade if need be before the harnessing of atomic energy to peaceful purposes proceeds apace.

We are, in fact, concerned here with a problem in the relation of science to ethics and the restrictions which ethics may place upon the use of the scientific method to which the Bishop of Durham directed attention in his Fisson Lecture. "Scientific method," said Bishop Henson, "is ethically conditioned in three respects. First, there are the moral obligations which attach to the scientific student by virtue of his manhood, and which cannot be cancelled by any scientific interest. Next, there are the restrictions on the methods of research which are imposed by the claims of those whom they affect. Thirdly, there are limitations on scientific research imposed by the quality of the results which they are designed to secure." Bishop Henson's lecture received nothing like the attention it deserved, for he was concerned rather to provoke thought about such issues than to enunciate answers to the questions he raised.

The formulation of an international code of ethics for scientific men may yet be distant; still more the political conditions under which it could be implemented effectively. But none the less, it must be remembered that the atomic bomb itself is the product of international scientific co-operation, and only international control can avert its widespread use. The future of humanity depends, as Prof. Mumford asserts, on the three Great Powers, not less than others, placing themselves strictly under the judgment and the surveillance of the rest of the world. To take the initiative in this matter is not merely their responsibility but also an act of prudence. Unless national sovereignty can be liquidated to that extent, the world organisation we have created will lack the authority to give security even to the United States, the U.S.S.R. or Great Britain.

"The authority of the United Nations must be unqualified and universal: every last laboratory and factory must be open to investigation by authorised international agents, responsible to the central world authority. The power to spread, limit or even outlaw scientific investigation must reside in such a body no less than the power to outlaw completely all national armies. Privacy, secrecy, sovereignty must be unconditionally surrendered to a common body whose prescribed powers must override all local administrative organs at every point that is necessary to ensure freedom from fear and freedom from unlawful aggression." This is Prof. Mumford's minimum price of security, and he recognizes clearly the great psychological change involved, rather than further knowledge; though he points to the value of developing further the sciences and arts relating to human institutions and biology. He asks of the man of science that he transfer to wider areas of knowledge and activity his capacity for self-abnegation, his well-trained inhibitions, his rigorous respect for controls. Religion, too, Mr. Mumford would mobilize in the cause, for institutional change will be insufficient unless we bring to it a fully awakened and constantly renewed personality; and he recognizes the high demand for self-discipline involved in the extension of the very processes of democracy to world organisation.

There are, in fact, questions here to which the United Nations Educational, Scientific and Cultural Organisation might well turn its attention at a later date. Meanwhile, apart from the particular problems of conduct which individual men of science may meet, it would be well for the scientific world to face the ethical considerations which are involved in the control of atomic energy, and indeed in the very prosecution of nuclear research.

"CANST THOU DRAW OUT LEVIATHAN WITH AN HOOK?"*

The Role of the Aged in Primitive Society

By Prof. Leo W. Simmons. Pp. viii + 317. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1945.) 26*s*. 6*d*. net.

THIS study by Prof. Simmons of the treatment of the aged collects into a single volume, from a number of sources widely distributed in geography and representing varying types and stages of culture, a very large assortment of examples of the way in which old age is treated by primitive peoples. The author states in his introductory matter that a preliminary analysis of his comparative material revealed significant contrasts on the basis of sex, and that marked difference in the treatment of the aged appeared to be correlated to varying factors in the environment, economics, kinship system, or religion of the group treated. Correlations between the physical and cultural traits described, and the environmental or other circumstances apparently determining or affecting them, are examined accordingly, and an analysis is made of the traits examined: the relative importance of each trait in its culture setting is estimated and the results indicated by a coefficient of plus or minus to two decimal points.

In effect, all this is an attempt to apply the methods of an exact science to material which, as it exists at present, is not really of a proper nature to be so treated, and if Prof. Simmons's book had no other merit, it would be of importance as a demonstration that material collected by the most careful ethnographers is not really susceptible of this sort of treatment. It is perhaps unlikely that this method of dealing with sociological phenomena will ever become satisfactory, but its application to data

* *Job* xli, 1.

that were never collected with a view to such treatment is probably dangerous and certainly unconvincing. It is not to be inferred, of course, that the author does not reach certain valid deductions. The conclusion "may be safely ventured", he tells us, that aged women have generally found it harder to get young husbands than old men have to get young wives. No statistical analysis, no weighted comparison of culture traits is needed to give us that information; nor is it an unexpected qualification that old women have found young husbands easiest to get in matrilineal societies—where, of course, they control the property. Indeed, one cannot avoid the suspicion that some of the conclusions reached are really rather the unconscious dictates of the author's preconceived ideas than the inevitable conclusions of any truly scientific process. Thus the payment of bride prices is, by the author's findings, expressly correlated in patrilineal societies to inferiority in the status of women. This is a view which is no doubt widely accepted, but, so far as many patrilineal societies are concerned, quite erroneously. No doubt but such payments are not found in matrilineal groups; in some cases they appear actually to originate in compensation paid by patrilineal bridegrooms to matrilineal families for the privilege of depriving them of a daughter's children; in any event they frequently occur where the bride is of higher social status than her groom. Where the converse holds and the father of the bride must pay a man to marry his daughter, her status will be found, in effect, to be inferior generally to that of her husband. This is a trait which the author does not seem to have examined; but if bride price be, as alleged, an indication of the bride's inferior status we are little better off for the knowledge, for it may be cause, or it may be effect, or it may be a remedy, since in many societies it certainly operates to secure consideration and regard for the bride. The truth is that the data are incomplete, and individual interpretations of them must almost inevitably differ. The mathematical method cannot really be applied to imponderable phenomena the values of which must be variously assessed by different individuals.

Nevertheless Prof. Simmons has collected a large number of illustrations of the various ways in which the aged are or have been treated, and if anyone wishes to know what sort of treatment is meted out to them by the races of man generally, here is the book to consult, albeit it might be better indexed. Nor does one come away with any confidence that the segregation of the aged poor in a civilized British 'workhouse', where the partners of a life-time may be separated, is really one whit more humane than the primitive Fijian practice of burying the aged and infirm alive with their own connivance and co-operation. There must be few of us who have not met with aged parties who no longer take pleasure in life, "which long for death, but it cometh not, which rejoice exceedingly, and are glad, when they can find the grave". Finally, to mention one aspect of the aged which the author passes over, it may be doubted whether any civilized method of disposing of one's aged parents can compete with the piety of the Massagetæ, of the Issidones, and of our Irish ancestors, who conquered their repugnance to cannibalism and devoured their dead parents mingled with a savoury stew that they might live again in their children, and whom Herodotus tells us were accounted righteous people on that account, while Strabo records it as a seemly deed.

J. H. HUTTON

ELECTRICITY SUPPLY IN GREAT BRITAIN

The Organisation of Electricity Supply in Great Britain

By Dr. H. H. Ballin. Pp. xv + 323. (London: Electrical Press, Ltd.. 1946.) 21*s*. net.

ELECTRICITY supply occupies a prominent place in the mind of the public at present, because the demand for electricity frequently exceeds the generating capacity, and because nationalization of the industry appears to be inevitable.

Dr. Ballin has made a careful survey of the growth of the British electrical industry from its commencement in 1880 until the present. He treats his subject mainly from the economic and political aspects, but gives some indication of the main technical features of transmission and distribution which had an important influence on rate of development.

In this notice, the progress of electricity supply in Britain will be outlined on technical and personal lines.

From the commencement of public electricity undertakings in the early 'eighties until 1914, numerous systems of heterogeneous types—direct current, 25-, 40- and 50-cycle alternating current—were founded. Only a few of the more enterprising undertakings could compete successfully with large industrial power plants. As described by Dr. Ballin, the period appears rather dull, but in fact it was remarkably colourful, and British pioneers were not lacking in enterprise or novel ideas.

During the First World War, the advantages of bulk supplies became evident to industrialists, and there was rapid expansion of all electricity supply undertakings in industrial areas.

The need for standardizing voltages and frequency was recognized by many engineers, and in 1919 the Electricity Commission was founded. The Electricity Commissioners surveyed the condition of the supply industry and established a statistical system on the basis of which the progress of that industry could be properly regulated. They attempted to bring about voluntary coalitions of undertakings into joint electricity authorities, but with little success.

The period 1919–26 was marked by the construction of a few generating stations, such as Dalmarnock (Glasgow), Barton (Manchester) and North Tees (Newcastle Electric Power Co.). These were deemed to be large stations; but it is worthy of note that a single boiler in the Ford power plant at Detroit could generate more steam than could the whole of the boilers in Dalmarnock.

The real achievement of that period was the passing of the 1926 (Electricity Supply) Act, which had as main objectives co-ordination of generation by means of the Grid system, and standardization of frequency of supply at 50 cycles/second.

The Central Electricity Board, set up under the 1926 Act and directed with extraordinary energy by Sir Andrew Duncan, brought about the construction of the Grid and the standardization of frequency between 1927 and 1934. This major constructional work demonstrated, above all, the efficiency of the British electrical manufacturing industry—all the novel transformers, switchgear, cables and other equipment being produced with remarkably little delay, and without technical setbacks. Between 1934 and 1939 the Board acted as a trading concern under peace conditions. It developed the intricate technical procedure required for operating all the British generating stations in parallel; and what is even more remarkable, secured adequate enthusiastic co-operation of all authorized undertakings through the medium of national and district consultative committees.

Exact information as to capital and operating costs, utilization of personnel and fuel consumption was obtained for every generating station. In 1939, the specific coal consumption for all electricity generated by public authorities had fallen to 1·48 lb. of coal per kWh., a figure about equal to that attained in the United States, the foremost country of the world in respect of generation and transmission of electricity.

During the War, the soundness of the Grid system was finally established, as supplies were afforded wherever required with few interruptions, although damage amounting to £10,000,000 was caused by enemy action and other war causes.

Dr. Ballin's references to the personalities of the electrical industry create an incorrect impression as to who was of real consequence. He gives undue prominence to jurists and government officials who made no contribution to progress. He resurrects the term 'arch-ohm' banteringly conferred on the late Mr. George Balfour. Mr. Balfour was one of the really dynamic personalities of the supply industry. He pioneered supply developments in Great Britain and abroad long before the planners had realized their possibilities. His last British ventures were in territories in north Scotland which had been rejected as uneconomic by established authorities, and the power systems he established there must have been of inestimable benefit to the Services during the War.

In the controversy as to the relative merits of company and municipal undertakings, Dr. Ballin inclines to favour the latter. Municipalities in general provide electricity at lower cost to the consumer than do companies, but the reason for this lies in the more concentrated load areas rather than in the type of organisation. Success also depends to a great extent on the personality of the individual managers, as can be verified strikingly by reference to the sudden impetus given to development of Belfast and Hull municipal concerns and the Central London Electricity Ltd. at certain stages.

Dr. Ballin is concerned at the relatively poor increase in use of electricity in Great Britain, and points to defective organisation and heterogeneous tariffs in explanation. In the reviewer's opinion the reasons are much more deep-seated. Sir John Orr's 40 per cent of undernourished cannot interest themselves deeply in electrical development until they are fed and properly accommodated. The better-paid artisans and middle classes are only now beginning to realize what an inexpensive boon electricity can be to them in their homes.

Wealthier people are being forced to use electricity because of lack of domestic help. Recent spectacular and embarrassing increases in the demand for electricity provide clear evidence of public awakening to its value.

In considering the possible effect of nationalization on electricity supply it is salutary to compare the cost and quality of the telephone service with that of the light and power service. A telephone call at a minimum of 2*d*. compares most unfavourably for value with a kilowatt at 1*d*. per hour. The G.P.O. engineering is efficient, so that it is natural to conclude that the high cost and indifferent service are due to bureaucratic control. It is to be hoped that no additional obstacles will be put in the way of the British electricity supply industry, which is now well on the way to becoming the most efficient national electrical organisation in the world.

Dr. Ballin's book contains much useful and interesting information. His suggestions for an overriding national electrical organisation are well worth examination, although they do little more than indicate the complexity of the economic, legal and political situation of the industry. In the event of a new edition being required, the index and bibliography could with advantage be extended. One work in particular is specially worthy of mention, namely, "The Development of the Generation and Distribution of Electric Power in the British Isles"*. It was justly described by the late Sir John Snell as "the best brief epitome of the history of electricity in Great Britain". C. W. MARSHALL

* Institution of Civil Engineers. Institution Lecture to Students. Session 1928–29.

MODERN PROBLEMS OF COLONIAL LAND TENURE

Land Law and Custom in the Colonies

By Dr. C. K. Meek. Pp. xxvi+338. (London, New York and Toronto: Oxford University Press, 1946.) 21*s*. net.

TWENTY years ago discussions of Colonial land legislation and policy were focused on the question of the alienation of land to non-natives, particularly in Africa, and the adequacy of the provision made to safeguard the rights and interest of native peoples. The importance of securing to them areas of land sufficient for their existing and estimated future needs was considered so urgent that this was the subject of a special clause in the agreements placing African territories under mandate; and the question whether native populations had, in fact, been injured by the grant of land to settlers was a matter of bitter controversy in some British Dependencies.

To-day the emphasis has shifted. In most Colonies the days of large-scale alienation are over, and further white settlement, if it takes place, will be on land already allotted to this use. In Central Africa most of the concession area granted in the optimistic 1880's has reverted to the Crown, as it has become evident that there would be no demand for it from European farmers.

The damage done in the meantime through local overcrowding of native areas remains; but this is now seen as only one aspect of a much wider problem —the problem of the adjustment of native customary tenures to modern conceptions of the use of land. Dr. Meek has surveyed the bewildering diversity of the Colonial empire, described the special circumstances and legislation of a number of different territories, and underlined the main issues in a book which will be invaluable to administrators and sociologists alike.

The problems of present-day policy arise from the changes that are taking place in customary forms of land tenure with the change from a subsistence to a money economy. Land, over which the community, perhaps with a chief as its representative, formerly held an overriding right, is now coming to be the object of commercial transactions between individuals, in which the contingent rights of other members of the group are overlooked. There is a conflict between the two aims, both desirable, of encouraging the progressive farmer and protecting his more conservative kinsmen from dispossession. The magic of freehold has been found to have its black side. It may enable the farmer to raise credit for improvements; it often allows him to incur debts for unproductive purposes and leads to the loss of his land. Nigeria has considered legislation which would allow the mortgaging of crops but not of land. Zanzibar controls mortgages and lays down that neither land nor its produce may be made attachable for debt. Dr. Meek urges the need to provide agricultural credit on a sound basis as an essential supplement to legislation of this kind.

Customary systems appropriate to a subsistence economy and to a rotation of food crops and fallow cease to apply when the land is more intensively used, and devoted to commercial as well as subsistence crops. Several African Governments have made provision for grants of land to individual native farmers who find tribal systems inimical to the adoption of new methods. In recent years re-settlement schemes have been set on foot, as part of measures against sleeping sickness or simply to reduce congestion; the latest proposal for groundnut cultivation in Tanganyika aims at killing several birds with one stone. In such schemes Governments dare not risk the ruin of the soil by unsound practices and must retain the right to insist on certain standards of cultivation. The type of individual right which to-day is generally regarded as most satisfactory is that described by Lord Hailey in his introduction as "a usufructuary occupancy which secures full enjoyment of the land to the holder and his successors during its beneficial use, but enables the community to resume possession of a holding when beneficial use ceases, or to terminate possession on payment of equitable compensation for improvements effected".

Most Colonies, however, have not yet made up their minds as to the exact nature of the limitations to be imposed on the free disposal of land. In addition, many of them have to handle an intermediate situation, where individual title is not yet widely sought, but types of transaction in land which customary law does not recognize are becoming common in practice. In Africa the rule-making power of native authorities can have a significant influence on future developments in this field.

One of the great merits of Dr. Meek's book is that it shows how widespread these problems are, and it enables the reader to look at any territory with which he may be familiar in the light of the treatment of similar situations elsewhere. Dr. Meek finds the happiest answer to a number of typical questions in the 1940 Native Land Trust Ordinance of Fiji. This provides for the grant of private rights, but makes them subordinate to the needs of rural development and the maintenance of soil fertility. It empowers the Government to intervene not only if a native group is in danger of alienating more land than it can afford, but also if it is withholding land from beneficial use, and provides for the redistribution of land in accordance with changes in the population of landowning groups. The provisions dealing with compensation for improvements are commended to the notice of other Governments. Another important innovation is the establishment of local agencies, representing both Fijians and Indians, to advise the trust board in which the control of native lands is vested.

LUCY P. MAIR

BACKGROUND OF APPLIED SCIENCE

Les radiations

Par Prof. Charles Fabry. (Collection Armand Colin: Section de physique, No. 243.) Pp. iv + 220. (Paris: Armand Colin, 1946.) 60 francs.

Propagation de la chaleur

Par Prof. Charles Fabry. (Collection Armand Colin: Section de physique, No. 236.) Pp. 216. (Paris: Armand Colin, 1942.) n.p.

PROF. FABRY, who died in 1945, was well known throughout the world for his original work, and, in a smaller circle, for his skill as a lecturer and expositor. These two books, one published in 1942 and the other after his death, are therefore of special interest. They are of a type not common among English publications, being short treatments of very wide subjects which are neither popular books nor abbreviated technical publications. They are mainly concerned neither with fundamental science nor with technical applications, but with something intermediate. They deal with those theoretical considerations which lie immediately behind applied science. For example, in "Les Radiations" there is little about the wave theory or quantum theory of radiation. A considerable proportion of the space is given to the basic theory of the measurement of a radiation flux (spectral distribution curves of sources and sensitivity curves of measuring devices). Different types of measuring instruments are mentioned, but there is nothing about the technique of photometry and similar subjects. The reviewer understands, from inquiry, that these books were based on lectures given to people who would later have to use or to test scientific instruments (for example, engineering students and students who would later become technical assistants in testing and research laboratories). Such students need precisely what these books aim to give—not technical details which they will obtain elsewhere, nor fundamental theory which would appear to them far removed from their work, but some general ideas brought into immediate relation with their own work. The literature of science in English would be enriched by publications of this type.

Agreeing that the objective is good, we may reasonably ask how well the books fulfil their purpose. "Les Radiations" deals with the whole electromagnetic spectrum; but there is an uneven distribution of interest. One might indeed plot an 'intensity of interest' curve with a broad maximum in the visible spectrum, falling fairly steeply through the infra-red and ultra-violet, so that X-rays and radio waves are mentioned only occasionally. In addition to chapters on sources and receptors there are a chapter on the properties of materials (including transmission by metals as well as by insulators), and a discussion of chemical and biological effects of radiation. The reader need not have any mathematical knowledge beyond elementary algebra. Great skill has been used to compress the material into the space available under the handicap imposed by the virtual absence of equations. The total effect, however, is that of an overcrowded stage—a play in which too many actors appear to speak a few brief lines. One can only regret that M. Fabry had not twice the space at his disposal.

The second book, "Propagation de la chaleur", is of the same length; but the subject is smaller and has been clearly delimited. The author is able to deal adequately with the processes of conduction, convection and radiation, and to give a brief but satisfactory treatment of such matters as the difference in temperature between the surface of a wall and the layer of air in contact with it. The reader is assumed to have a knowledge of calculus, including the simpler differential equations, but Bessel functions, etc., are not introduced. This book can be recommended to engineers and architects who may be concerned with the heating of buildings. It would also be helpful to honours students in physics, who may gain from it both a good summary of matters of theoretical interest and an understanding of the relation between laboratory work on heat and some problems of practical importance. A translation of this book would be very welcome. R. W. DITCHBURN

MATHEMATICAL THEORY OF ELASTICITY

Mathematical Theory of Elasticity

By Prof. I. S. Sokolnikoff, with the collaboration of Asst. Prof. R. D. Specht. Pp. xi+373. (New York and London. McGraw-Hill Book Co., Inc., 1946.) 22*s*. 6*d*.

THE appearance of a treatise in English upon the mathematical theory of elasticity is an event the potential importance of which may be judged by the fact that the author, in his frequent suggestions for collateral reading, refers to only three such, those of Southwell, Timoshenko, and Love. In spirit and content Sokolnikoff's book differs greatly from each and all of these. It may be described by a possible sub-title: "A pure mathematician surveys topics related to certain problems in the mathematical theory of elasticity". It is symptomatic of the change in outlook of American mathematics over the past few decades.

The book falls naturally into three sections. The first (Chapters 1–3, pp. 1–96) is devoted to analyses of stress and strain, the stress-strain relation, and the equations of equilibrium. The main feature of this section is the systematic use of the tensor notation. The second section (Chapter 4, pp. 97–276) is mostly concerned with the extension, torsion and flexure of beams, while the third section (Chapter 5, pp. 277–345) deals with variational and associated methods, illustrated mainly as applied to the torsion problem. Frequent suggestions for collateral reading and sets of exercises are excellent features, and the appendix —a collection of important formulæ—is very useful.

From the above it will be seen that this book contains matter not to be found in the other treatises already mentioned—but the converse is also true. Only a small group of elastic problems is solved, namely, those reducible to two-dimensional boundary problems for Laplace's or Poisson's equation. Biharmonic analysis does not find a place; but we are promised a companion volume containing a systematic treatment of plates and shells based on the fundamental differential equations.

In the first section the tensors are cartesian; the suffixes are all subscript and the ideas of covariance and contravariance do not occur. (Formulæ for polar co-ordinates are derived in Chapter 4, and are there given in extended notation.) Upon the conciseness of the tensor notation there can be no question. But it is open to question whether the physical ideas must first be grasped in a familiar notation before the more compact symbolism can be really useful, and also whether the difficulties of new ideas and new symbolism are likely to be simultaneously overcome by the average student. When one has mastered the ideas expressed in the extended notation, then the advantages in succinctness of the tensor notation become evident. The remainder of the volume is, however, independent of tensor notation, for, as the author realizes and indeed explicitly states, this symbolism loses its magic when confronted by specific problems.

The second section first covers much familiar ground using familiar notation, but includes also modern ideas, such as Stevenson's specification of the flexure functions, and the use of complex variable methods for solving torsion and flexure problems. In making available the work of the Russian school along the latter lines the author has rendered a service. The emphasis throughout this section is upon exact formal solutions as ends in themselves with little regard to their suitability for technical calculations.

In Chapter 5 the author concerns himself with approximate methods, both formal (like those of Rayleigh–Ritc) and numerical (the finite difference approximation). Although applications are limited to a few cases of the torsion problem, the survey is valuable, especially the account of methods of delimiting exact values between upper and lower bounds.

As has been implied already, the outlook is that of a mathematician, of a man of science rather than a technician. Emphasis is upon method rather than result—rightly so, in the sense that it is for methods that the technician consults the mathematician. But we fear that the technician will not find this book easy reading. Although the author from time to time makes a conscious effort to take the reader behind the scenes and show him how the mathematical effects are produced, he cannot entirely escape the mathematician's habit of asking one to 'consider the expression . . .' which appears rather like the rabbit out of the conjurer's hat. Again, the engineer may well ask how the mathematician knows which method to use upon any problem—and in particular why the complex variable method be not applied to the torsion or flexure of either the elliptic cylinder or the rectangular prism. In what should be one of the most telling sections of the book, where the complex variable method is applied to the cardioid section, the essential simplicity of the method is masked by analysis which seems clumsy and is not easy to follow.

There is much repetition, both in the text and in the references. In the text it may possibly be justified, but it is surely unnecessary and wasteful to give full bibliographic references to (for example) Love's "Treatise" every time it is mentioned, or, in two footnotes on the same page, to repeat title and reference in full to a paper cited. Choice of notation is not always happy, for example, the use of σ for a complex variable after its use for Poisson's ratio. Misprints are more frequent than one likes to see, although they should cause little trouble to an intelligent reader.

But it is clear that, although only a small field has been tilled, there is, for those who can winnow the grain from the chaff, a harvest to be reaped in this book. W. G. BICKLEY

ENGINEERING PROBLEMS OF FUTURE AIRCRAFT

A DISCUSSION arranged by the Royal Aeronautical Society was held in London on November 14, dealing with some of the engineering problems presented by future aircraft. The subject was divided into four main sections, each introduced by a paper, which covered the problems that are now appearing on the horizon in the world of aircraft design. They were, broadly speaking: engineering problems of large aircraft, tailless aircraft design, flying-boats with particular reference to their peculiar constructional problems, and power plant installations.

Engineering Problems of Large Aircraft

The most outstanding feature from this point of view is the fact that the increase in size brings with it complication and elaboration of detail that is the work of specialists, many of whom may not have had any interest in the smaller aircraft of the previous decade. It will need the co-operation of a team, not necessarily all aeronautical, who will develop their own products to suit the particular requirements of the aircraft. An obvious example of this is the movements of the control surfaces. The effort necessary for these will certainly demand some kind of power driving, coupled with an extremely delicate control of it, which may be done either by gyroscopic instruments or graded down so that the pilot can operate it by 'feel'. At present pneumatic, hydraulic, and electrical systems are available, and it will have to be determined which can be best developed to the larger sizes with the least added weight and bulk, and retain the most delicate yet reliable control of its workings. There is a good deal to be said in favour of electrical systems, as electric power has to be generated for lighting and radio purposes. Alternating current at a pressure of about 200 volts between phases seems to be the most promising, and its development for both reliability and safety may well be one of the problems in the next few years.

Size of aircraft is very dependent upon the route to be operated. The London–New York route appears to be the most difficult one envisaged for the immediate future. The great circle distance is 3,450 statute miles, but allowing for head winds and other eventualities a fuel load sufficient for 5,500 miles must be carried. Present-day knowledge, based on a 300,000 lb. aircraft, suggests that only about 8 per cent of this figure is available for paying load, increasing to 11 per cent with one intermediate stop or 13 per cent with two stops, using the type of passenger accommodation most suited to aerodynamic and structural requirements. A further complication arises in that it may be convenient to make the longer non-stop run at night, so that sleeping berths will have to be provided. The extra space for these governs the size and weight of the body, and through this the design of the whole machine. Aircraft on the shorter runs with intermediate stops may possibly not operate in this way; and, if travelling during day-time hours, will tend to develop into a machine of a different type.

The proportion of paying load on this type of large machine being so small, it is obviously important to achieve the greatest possible efficiency in structural design in order to keep the weight of this part down to a minimum. This postulates an accurate knowledge of the externally applied aerodynamic forces and the resulting internal loads in the structure. The most critical parts of such loads are those due to dynamic effects arising from vibrations. This necessitates a study of the natural frequencies of the proposed structure, and the effect of gusts upon it. Undercarriage action also induces vibrations with a similar effect. The mathematics of these problems is long and laborious, and needs checking by actual tests. Existing equipment is too small for full-scale tests on such large machines, both from the point of view of size and the magnitude of the test loads to be applied. The design and construction of large test apparatus will constitute a research in itself, or alternatively the relationship between model and full-scale behaviour will have to be developed to a state of certainty in prediction, from both the mathematical and the physical outlook.

The correct use of materials gives another field of extremely interesting development. An aircraft designed to-day for production has to conform to the specifications of materials that are available in sufficient quantities, both as to physical properties and sizes. The designer of the large machine, regarded as a researcher into future design problems, may well consider it advisable to choose materials that give him the most efficient structure, thus in effect creating his own materials specifications, and giving a lead to the materials manufacturer. For example, in the case of a stressed metal skin, the joints between individual sheets give an appreciable additional weight, and another problem is to attain a good smooth outer surface. If sheets of double the present-day maximum dimensions were available, the area of the joints on an average aircraft skin would be reduced by about 40 per cent. Smaller tolerances in workshop production would allow much finer limits in stressing at the design stage and consequent saving of weight. This may call for changes in the materials manufacturer's workshop technique, or possibly the development of new alloys that are capable of more accurate finish in their manufacture.

Tailless Aircraft Design

There are aerodynamic reasons, outside the scope of this discussion, that dictate that the supersonic speed aircraft flying in the stratosphere will need to have wings with a pronounced 'sweep back', of at least the order of 25°. The tail surfaces that are necessary for control purposes may conceivably be carried on these wing tips, now far enough back for the purpose. This will give a useful saving in both drag and structure weight, as the long cantilever body, which serves little useful purpose other than to carry the tail, will not be necessary. This is really only a secondary effect, the principal problem of the future being that of the swept-back wing rather than the tailless aircraft. This problem resolves itself into three main sections: the aerodynamics of the question at lower speeds necessary for take-off and landing; compressibility effects; and 'aeroelastic' problems of dynamic loading as already discussed in the previous paper.

The outstanding problem to be investigated is the early stall, initiated at the wing tips. Their position relative to the line of flight alters the aerodynamics of the problem, and a combination of increase of local lift, reduced negative camber, outward drift of the boundary layer of air, and interference by a forced outward flow of the air from beneath the wings, causes premature stalling and lack of efficiency of the original tail surfaces now placed there. Investigations so far carried out suggest that an entirely separate design of the wing tips will need to be undertaken. The present knowledge of the behaviour of such devices as slots, flaps, etc., used as lift assisters, may need to be extensively modified when fitted in this area. Taper plan form for a wing, efficient in many respects for normal wings, may be definitely bad with swept-back wings owing to their disruptive effect upon the boundary layer behaviour. The control of the boundary layer by suction and ejection of air flowing over the plane, and even the design of completely different aerofoil shapes, are possible avenues of research into this problem.

Compressibility effects at high speeds need perhaps the greatest research in the future. This lack of precise knowledge of the behaviour of the aircraft is not confined to swept-back wings, but the problem is a degree more complicated in these cases. The variation of aerodynamic characteristics, the precise effect of sweep-back, and the problem of the stall, all need re-attacking under these conditions. A mass of theoretical and experimental data is beginning to become available, and assimilation of it and co-ordination of effort is a necessity.

The problems of aero-elasticity are an extension of similar questions on more conventional aircraft, considerably complicated by the fact that the wings are swept back. Spar bending under external loads produces a change of incidence, whereas it does not have this effect in a straight wing. This sets critical limits to most of the manœuvres, the investigation of which is naturally complicated by the introduction of a second variable. The possible effects of aileron reversal upon lateral control and stability, and the chance of its inducing wing flutter all need investigation, both mathematically, experimentally, and in full-scale flight.

Flying-Boat Problems Related to Production and Pressurization

This discussion, although primarily on the large flying-boat, raised general problems of the relationship between design and production that apply equally well to all large aircraft. Up to the present, design has generally been the first consideration, as indeed it must be with anything in the experimental development stage. Light and efficient structures have often been achieved at the cost of complication, with its attendant cost and slow production. Designers have been loth to increase structural weight, with its attendant reduction in useful load carried, in order to assist production. If the production engineer is willing to regard aircraft production as a separate problem, needing its own technique, co-operation with the designer should produce aircraft that will reflect the advance in aeronautical knowledge without necessarily being a bad production proposition. A reduction of the total man-hours needed for the complete building of an aircraft is the same thing, whether it results in cheapness for commerce or quick production for war.

Planning for production is obviously dependent upon the question of possible modifications found necessary during normal use. The present-day practice of building a few prototypes is not good from this point of view, and now that the tempo of development can be somewhat slower, it is possible that an extremely active development department using a larger number of pre-production machines could ensure that the final tooling for production would not be subject to many further alterations. Another criterion from this point of view is that of keeping the number and variety of parts down to a minimum in the design stage. The Republican Aviation Corporation in the United States re-designed the Sea Bee, as its cost of production was more than twice what the manufacturers had envisaged. A radical alteration to the structure involved them in considerable design trouble, as many of the re-designed features were not amenable to accepted strength computation methods, but the manufacturing costs were finally reduced to the required figure. Changes in detail design methods that are in danger of becoming stereotyped are foreshadowed here.

Another problem that has arisen in the production of large flying-boats which will certainly be common to all large aircraft is that of the minimum degree of accuracy needed. Laminar flow in the boundary layer demands exceptional finish of surfaces, and interchangeability of parts sets a limit on working tolerances. Unnecessarily small limits in either of these are wasteful, and much more precise information on these is needed.

Pressurization of cabins for high-altitude flying now appears to be essential with the adoption of the gas turbine. This creates a fresh outlook on the body structure, which now has to be a pressure-tight shell, in addition to being of the required strength. Although a circular cross-section is the stiffest shape, it is uneconomical for passenger accommodation, especially when large enough to accommodate more than one deck. A cottage loaf or figure of eight cross-section appears to be promising. Another question to be investigated is whether the whole body, or only the cabins, need be pressure tight. This is not only a question of human life in the cabins. The pressure differential between the outside and inside will affect the structural strength needed, and although pressure may not matter, the effect of temperature and humidity may affect certain kinds of cargo.

Power Plant Installations

The most outstanding feature of the future under this heading will be the possible change in general outline of aircraft due to the introduction of the gas turbine. This will be caused not only by the different requirements of the power plant itself, but also by changes in aerodynamic layout due to higher speeds and high-altitude operation. Military aircraft may also be extended to rocket-propelled, pilotless projectiles, although the more conventional aircraft will still be required for transport, observation, and possibly interception and destruction of enemy aircraft. Civil aircraft will tend to develop into types governed by range. The high fuel consumption of jet propulsion means that propeller drive will continue for these, although possibly driven by gas turbines. Medium-range, say up to 1,000 miles, and shorter-range aircraft may possibly use the highest possible speeds with jet propulsion, as the relatively short journeys will allow a more intensive use of the machine on the turn-about principle. Freight aircraft may well develop into two types, the faster catering for the transport of perishable goods, when the extra costs of high speed may be justified. The piston engine–propeller combination will probably remain at the lower end of this scale, with the turbine-jet at the other end.

The future development of power plants is obvious in its direction. The piston engine with propeller is efficient mechanically, at least up to speeds where compressibility effects are serious. It has reached a high state of development and does not appear to be likely to undergo any radical change that will enlarge its present application. The gas turbine with propeller gives an engine that is relatively new and capable of development, although its most obvious progress, namely, increase of power, will be limited by the propeller's ability to turn it into thrust, which cannot go much further. Reduction in vibration, noise, fire risks, and such secondary matters are more promising lines of improvement. The gas-turbine-jet combination is capable of unlimited development, so far as the aircraft is able to use its extra power, and the human element can stand the high accelerations inseparable from high speeds, assuming that research succeeds in improving the efficiency of jet propulsion and reducing the high fuel consumption, which up to the present limits the possible range.

THE MAGNITUDE OF MICROBIAL REACTIONS INVOLVING VITAMIN-LIKE COMPOUNDS

By HENRY McILWAIN

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CHANGES brought about by one or a few units of catalyst in each cell of a living organism are postulated in biochemical interpretations of genetics. The nature of the changes is unknown; but a favoured suggestion is that they may consist of participation in the formation of enzymes, or their 'shaping' from otherwise synthesized protein molecules[1]. This is a theoretical conception, and no reactions defined in terms of substrates or products, and studied by biochemical techniques, have previously been recognized as due to one or a few molecules of enzyme per cell. Reasons are given below for thinking that a certain class of reactions with vitamin-like substances in bacteria may be due to such enzymes.

Formation of Vitamin-like Substances by Bacteria

Authors have previously pointed out the relatively small quantities of known vitamins which are associated with individual cells. When expressed as molecules per cell, numbers of the order of 10^3 to 10^5 are found in the case of many bacteria[2,3] (*b*, Table 1). Consider now their rates of formation in growing bacteria. Cultures of the organisms of Table 1 for which data are available[2] doubled in population each hour. Thus, for example, some 5,000 molecules of aneurin were produced in an hour by (initially) one cell. Allowing for its growth by the factor $\log_e 2$, the rate of production becomes 3,500 molecules/cell of 10^{-13} gm. dry wt./hr., or about 1 molecule/cell/second. These rates (*c*, Table 1), are likely to give low estimates of the synthetic ability of bacteria, for the following reasons. (1) The vitamins are found also in the fluids in which the bacteria have grown. The values *d* of Table 1 take this into consideration. They are likely to be high if vitamin production has continued in the absence of growth, as can sometimes occur[4]. (2) The bacterial generation time of 1 hour, which was employed in calculation, is three times that typical of good conditions of growth. Rates treble those of column *d* (Table 1) give a range of values of 0·24 to 33 molecules/cell/sec., with exceptional upper values for pantothenic and nicotinic acids of 120 and 540 molecules/cell/sec., respectively. (3) The extent to which these rates represent metabolic reactions which are at all well defined needs independent demonstration. They may be the outcome of a balance between vitamin production and breakdown. Evidence in specific instances is considered later.

Rates of Enzyme Reactions

The velocities of several reactions catalysed by enzymes can be expressed in terms of the numbers of molecules of substrate which one molecule of enzyme causes to react per second. Such values—the turnover numbers of the enzymes—are usually determined under optimal or physiological conditions of temperature and *p*H, and with excess substrate. Values are given in Table 2. In general, they are seen to be greater than the numbers of molecules of

TABLE 1. QUANTITIES OF VITAMIN-LIKE SUBSTANCES FORMED BY BACTERIA[2], AND THEIR COMPUTED RATES OF PRODUCTION

Compound	Organism	Quantity associated with cells[3] (*a*) μmol./gm dry wt	(*b*) Molecules/cell of dry wt. 10^{-13} gm	(*c*) Rate of production of vitamin of cell in culture doubling in size each hour (molecules/cell/sec.)	(*d*) Value corresponding to (*c*) but including vitamin of culture fluid. (molecules/cell/sec.)
Aneurin					
	Aerobacter aerogenes, aerobically	0·037	2200	0·4	0·8
	Aerobacter aerogenes, anaerobically	0·050	3000	0·6	1·0
	Serratia marcescens	0·090	5400	1·0	1·7
	Pseudomonas fluorescens	0·086	5200	1·0	2·8
	Proteus vulgaris	0·070	4200	0·8	0·8
	Clostridium butylicum	0·031	1900	0·4	1·5
Riboflavine	(above five bacteria)	0·12–0·18	7200–11,000	1·4–2	2·4–11
Nicotinic acid	,, ,, ,,	1·6–2	96,000–120,000	18–23	31–180
Pantothenic acid	,, ,, ,,	0·4–1·6	24,000–96,000	4·6–18	5·2–41
Pyridoxine	,, ,, ,,	0·035–0·11	2100–6600	0·4–1·3	1·1–5·1
Biotin	,, ,, ,,	0·007–0·029	420–1800	0·08–0·34	0·08–3·2
Folic acid	,, ,, ,,	0·003–0·02	180–1200	0·03–0·25	0·25–1·2
p-Aminobenzoic acid[5]					
	Aerobacter aerogenes	0·120	7700	1·50	4·0
	Serratia marescens	0·048	3100	0·60	1·2
	Pseudomonas aerugenosa	0·073	4700	0·92	5·5
	Streptococcus hæmolyticus	0·060	3800	0·74	1·1
	Escherichia coli	0·270	17,000	3·32	3·9

TABLE 2 CATALYTIC ACTIVITIES OF SOME ENZYMES

Enzyme (source)	Coenzyme or prosthetic group	Substrates	Turnover number (mol /mol. enzyme/sec.)
Carboxylase (yeast)[6]	Aneurin pyrophosphate and Mg	pyruvic acid	22
Fumaric hydrogenase (yeast)[7]	flavin-adenine dinucleotide	fumaric acid and hydrogen donors	40–50
d-amino acid oxidase (pig kidney)[8]	,, ,, ,,	alanine and oxygen	33
Diaphorase (pig heart)[9]	,, ,, ,,	dihydro coenzymes I and II	130
Triosephosphate enzyme (yeast)[10]		3-phosphoglyceraldehyde and cozymase	300
Alcohol dehydrogenase (yeast)[11]		alcohol and cozymase	300
,, ,, ,,		acetaldehyde and dihydrocozymase	450
Laccase (*Rhus succedanea*)[12]	Cu	p-phenylene diamine	40
Polyphenol oxidase (mushroom)[13]	Cu	catechol	800
Phosphate-transferring enzyme of fermentation (yeast)[15]	Mg	3 phosphoglyceric acid and adenosine triphosphate	600
Phosphate-transferring enzyme of fermentation (yeast)[15]	Mg	1 · 3 diphosphoglyceric acid and adenosine diphosphate	5500
Hexokinase (yeast)[14]	Mg	glucose and adenosine triphosphate	230
Phosphorylase (muscle)[16]	adenylic acid	glucose-1-phosphate and glycogen	660
Carbonic anhydrase (beef erythrocytes)[17]	Zn	HCO_3^-	14
Yeast polypeptidase[18]		leucyldiglycine	17,000
Catalase (ox liver)[19]	Fe-porphyrin	hydrogen peroxide	44,000

vitamin-like substances with which one bacterial cell was computed to react in the same period of time.

Several instances are quoted in which enzymes from yeast cause reactions in compounds of Table 1, with high velocities. The turnover numbers of carboxylase, fumaric hydrogenase, hexokinase, a triosephosphate enzyme and alcohol dehydrogenase range from 22 to 450 mol./mol./sec. This implies that the derivatives of aneurin, riboflavin, and nicotinic acid which constitute their substrates, coenzymes or prosthetic groups are caused to undergo changes with that frequency. Corresponding numbers referring to these compounds, in column d of Table 1, range from 0·8 to 180. This justifies further consideration of the possibility that some stages in the syntheses of Table 1 may be due to one or a few enzyme molecules per cell.

The following factors render the above comparison indirect, but not invalid. (1) Turnover numbers have not been given for bacterial enzymes; but Table 2 includes values for enzymes of plant, animal, and microbial origin, without showing any marked trend in the values, dependent on the source of the systems. (2) Where most direct comparisons are available between Tables 1 and 2, the reactions concerned are in the first case the synthesis of coenzyme constituents, and in the second their behaviour as coenzymes or prosthetic groups in hydrogen transport. However, the group of enzymes concerned are not unusual in turnover number when compared with others of Table 2. Aneurin, riboflavin and nicotinamide are not unusual in comparison with other substances of Table 1. (3) As the quantities of vitamin-like substances associated with cells are relatively small, it appears likely that the enzymes concerned with them are not reacting at the velocities represented by their ordinary turnover numbers. If the quantities of vitamin-like substances associated with cells and quoted in Table 1 are expressed as molar concentrations in cells with assumed water-contents of 80 per cent, values of 5×10^{-6} to $5 \times 10^{-4} M$ are obtained. These are maximum values for the concentrations of the substances concerned; compounds acting as intermediates in one or more reaction series would be expected to appear only transitorily and in very low concentrations Experimental evidence on the effect of such factors is considered below. (4) Questions relating to cellular organisation are likely to present major difficulties in comparing reactions in living cells with those in isolated enzyme systems. The functioning of many enzymes, including certain ones causing reactions in vitamin-like compounds[4], is, however, independent of growth. Most of the instances of Table 1 concern syntheses within the cell of small quantities of vitamin-like substances from simple materials available in relatively large quantities, and used in relatively large quantities within the cells for general syntheses. Limitation through unfavourable permeability appears unlikely. Production of the vitamins of Table 1 presumably represents the outcome of many enzymes acting in parallel and in series, so that the overall rate would be limited by that of the slowest reaction. The rates of Table 1 may then be much slower than those of which most of the enzymes concerned are capable. Tending in the opposite direction is the fact that, whereas the values of Table 2 refer each to one enzyme, those of Table 1 may refer to the sums of more than one synthetic series; more than one derivative of nicotinic acid and of riboflavin are known to be catalysts. It is therefore desirable to have data more biochemically defined than that of Table 1.

TABLE 3. VELOCITIES OF DIRECTLY OBSERVED MICROBIAL REACTIONS WITH VITAMIN-LIKE COMPOUNDS

Organism	Reaction	Velocity, mμmol./gm./sec.	Velocity, molecules/10^{-12} gm./sec.
Proteus vulgaris[20]	Inactivation of nicotinamide (37°)	0 08	5·1
Hæmophilus parainfluenzæ[21]	Inactivation of cozymase (38°)	0 17	11
Yeast[20]	Inactivation and reactivation of cozymase (25°)	0 18–0·27	12–18
Yeast[21]	Interconversion of coenzymes I and II (30°)	0·12–0 15	8–10
Escherichia coli[4]	Synthesis of pantothenate from inorganic salts and glucose (37°)	0·78	50
,, ,,	As above, with added β-alanine (37°)	8·5	540
Pseudomonas aeruginosa[4]	Synthesis of pantothenate from inorganic salts and lactate, with or without β-alanine (37°)	0·14	9
,, ,,	As above, with added pantoic acid (37°)	0·47	30
Proteus morganii[4,21]	Inactivation of pantothenate (37°)	0·39–1·9	25–120
β-hæmolytic streptococci[4,22]	,, ,, ,,	0·36–0·64	23–41

Rates of More Specific Microbial Reactions with Vitamin-like Compounds

Table 3 represents the best approximation to such definition which it appears possible to give at present. The processes listed are mainly brought about by non-proliferating suspensions of bacteria or yeasts, but in no case are both their substrates and their immediate products known. The range of values for reaction velocities in this table is seen to be comparable with that computed from Table 1. Some processes will now be considered individually in an attempt to assess the extent to which they represent at all well-defined reactions.

Pantothenate. One of those examined most fully concerns the inactivation of pantothenate by hæmolytic streptococci[22], a process leading to unknown products which do not have the growth-promoting activities of pantothenate. Kinetic experiments with non-proliferating streptococcal suspensions showed rates of inactivation of 23 to 41 molecules/10^{-13} gm./sec. in the presence of excess pantothenate[23]. This is, therefore, an instance in which the reaction velocity is not likely to be limited through the vitamin-like compound which is acting as substrate being present in a suboptimal concentration. Also, pantothenate has been observed to have relatively free access to the system involved in its degradation: the process commenced without delay on mixing bacteria and pantothenate[23]. The rate of the reaction with a given batch of organisms was little affected by a wide variety of circumstances (including even the presence or absence of growth[4]) which might have been expected to disturb the rate of reaction if it were due to a balance between synthesis and breakdown. Pantothenate synthesis was not detected in the streptococci in any circumstances, even when the inactivation was inhibited. This could be done in a very specific manner, which suggested the inactivation to be due to a single and characteristic system[21,22]. Inactivation of a growth-factor serving as catalyst might be due to processes of attrition in functioning, not directly relevant to bacterial metabolism; but the reaction in pantothenate is closely correlated with its functioning in growth. Thus, a series of compounds structurally related to pantothenate inhibited, to similar extents, both streptococcal growth and the inactivation of pantothenate; and a given analogue inhibited in parallel both the inactivation and growth, in a series of bacteria of varying sensitivities[21]. Inactivation might also be a side reaction or minor activity on the part of enzymes which react much more rapidly with other substrates. The correlation between inactivation and functioning of pantothenate renders this also improbable.

An enzyme of turnover number 23–41 mol./mol./sec. would be among the less active ones of Table 2. A value for a turnover number of pantothenate in one of the organisms (*Pr. morganii*) of Table 3 is already available[24]. This concerns the increased carbon dioxide produced or oxygen absorbed during processes catalysed by pantothenate, and gives values of about 20 mols. (O_2 as H_2 equivalents)/mol. added pantothenate/sec.

Many of the reasons for querying the relevance of pantothenate inactivation to the present topic do not apply to its synthesis. This normally (Table 3) proceeds in *E. coli* and *Ps. aeruginosa* at rates comparable to those of the inactivation. The synthesis requires amide formation; values reported for a yeast polypeptidase suggest the high value of 17,000 as turnover number. The highest rate of synthesis of pantothenate which has been found (Table 3) was that of 540 molecules/10^{-13} gm./sec., observed in the presence of relatively high concentrations of β-alanine. The effect of increasing concentrations of β-alanine was presumably to saturate the systems concerned in a late stage of pantothenate synthesis.

Nicotinic acid derivatives. Reactions of synthesis, inactivation and interconversion occur in nicotinic acid derivatives with velocities not far removed from 10 molecules/10^{-13} gm./sec. (Table 3). This itself suggests a group of defined reactions, and adds to the significance of the processes of inactivation. In the conversion of coenzyme I to II (Adler, Elliot and Elliot[20]), a large excess and relatively high concentration—about $10^{-3}M$—of substrate was employed. In the inactivation of cozymase by apozymase (Lennerstrand[20]) the reaction velocity was little affected by variation in cozymase concentration over a 50-fold range which rose to $10^{-4}M$. Similar systems responded rapidly to the coenzymes as catalysts, indicating that these substances had relatively free access to the cell interior. The velocity of interconversion or inactivation of the coenzymes is thus unlikely to be limited by the substances being present in suboptimal concentrations. The velocities may in certain cases be limited by the progress of concomitant reactions (McIlwain[20]; see also below), but in the instances of Table 3 which are so conditioned, the concomitant reactions also were proceeding rapidly.

The number of molecules reacting per 10^{-13} gm. per second in the systems of Table 3 is again low in comparison with the change which can be brought about by one enzyme molecule, being a tenth to a fortieth of that which hydrogen transporting systems of Table 2 can bring about in cozymase in the same time[25]. The interconversions of coenzymes I and II in yeast preparations are among the most defined of the reactions of Table 3, and involve phosphate transfer. Of the reactions of Table 2, that between phosphoglyceric acids and adenine derivatives, catalysed by a purified enzyme from yeast, has turnover numbers of the order of 600–5,500 mol./mol./sec. Muscle phosphorylase and hexokinase also give numbers much above the 10 molecules/10^{-13} gm./sec. of Table 3.

General comparison of rates. As a whole, the values of Table 2 are much greater than those of Table 1 (columns *c* or *d*), and Table 3. To take a very crude measure, the average value in molecules/unit/sec. in Tables 1 and 3 (cell as unit) is about one-tenth that of Table 2 (molecule as unit)[26]. The main criterion in compiling the tables has been the availability of data, and close correlation is not to be expected. The difference in mean rates is, however, such as to emphasize the small probable number per cell of molecules of the relevant enzymes. At the same time, the difference is one which can be understood in terms of the preceding discussion. Supply of more immediate precursors increased the rate of pantothenate synthesis three-fold or ten-fold in *E. coli* and *Ps. aeruginosa* (Table 3).

Possible Significance of Enzymes which Occur to the Extent of only a few Molecules per Cell

Relation to the gene. Reactions such as those of Tables 1 and 3 can be affected in micro-organisms by irradiation, in a manner suggesting the disturbance to be due to changes in a single unit of inheritance[1,27], and suggesting such a gene to control one biochemical step. The minimum activity required theoretically in the gene is reproduction of itself, and some further activity by which other cell-processes are affected. The further activity may also be a catalytic one[1], or may be a control of independently reproducing entities capable of catalysis[28]. The production of enzymes occurring to the extent of only one or a few molecules per cell needs special consideration in such schemes, which would require the production of one enzyme molecule per gene per 15 min. or so, and introduce the necessity of coupling accurately with cell division two processes each concerning individual molecules: the formation both of one gene and of the associated enzyme. Such difficulty would not arise in the case of an enzyme of which some hundreds of molecules occurred in each cell. But if stages in bacterial reactions with important cell-reagents, such as vitamin-like compounds, require only a few enzyme molecules per cell, it appears simplest to suppose that production of the enzyme concerned is in some way intimately associated with reproduction of the gene. One conclusion consistent with the present argument would be that the reactions concerned with vitamin-like compounds represent, themselves, the hetero-catalytic activities of genes. The suggestion that genes may exhibit enzyme action in the ordinary sense is not new, nor is the suggestion that critical processes may be carried out by one or a few enzyme molecules per cell[29]. But the possibility that such enzymes may be responsible for a particular group of already investigated reactions, in substances the biochemical role of which is of known importance, affords starting points for specific investigations and a defined set of working hypotheses.

It will be observed that if systems concerned in the metabolism of pantothenate and *p*-aminobenzoate are fairly closely related to genes, so also are the actions of their competitive inhibitors, pantoyltaurine and sulphanilamide.

Metabolic interrelationships. Reactions such as those of Table 3 which proceed at the speed of some mμmol./gm. dry weight of organism/sec. have been termed reactions of mμmol. order[30]. Several of them show connexions with other cell processes which are of additional interest, if they are brought about by entities closely related to genes. Thus, pantothenate not only has a catalytic role, probably in pyruvate metabolism[24], but also the inactivation of pantothenate requires a concomitant reaction such as glycolysis[21,22] (of some μmol./gm./sec. or μmol. order). Coenzymes I and II are not only required in carbohydrate degradation, but also their synthesis and breakdown are conditioned by the occurrence of such reactions[20]. A control by the more ordinary cell processes of μmol. order is thus imposed on the activities of certain enzymes concerned with mμmol. reactions. Considering the potential effect in the opposite direction, it will be seen that if an enzyme conditioning a mμmol. process is operating with a turnover number of some 50 mol./mol./sec., then in the 20 min. of a bacterial generation it could have controlled the production of 6×10^4 molecules, for example, of a coenzyme capable of acting with a similar turnover number. The effect of the initial enzyme molecule could thus extend to $\frac{1}{2}(6 \times 10^4)^2$ or $1{\cdot}8 \times 10^9$ molecules (if of glucose, to $5{\cdot}4 \times 10^{-13}$ gm., or several times the typical bacterial mass), in this time.

The concentration of many enzymes (such as those concerned in μmol. reactions) even in bacteria involves the occurrence of large numbers of their molecules in each cell. Their relationship to genes is thus of the type in which one gene influences the production of large numbers of enzyme molecules. One might suppose in bacteria different series of genes, some concerned with the enzymes required in μmol. processes and others concerned with the coenzymes or prosthetic groups. If the first series conditions protein formation, the second would control reactions of mμmol. order in vitamin-like compounds. Enzyme and prosthetic groups would then be formed in roughly comparable molar quantities, the varying turnover numbers of different enzymes (Table 2) allowing considerable elasticity in such a scheme. The turnover numbers themselves are presumably biologically conditioned by the need for biochemical balance within the cell[33].

If one third of the dry weight of a bacterium of 10^{-13} gm. consists of protein, this would suffice for 2×10^5 molecules of molecular weight 10^5, which is a magnitude frequently found in enzyme molecules; several of those of Table 2 are of this order. There are at least 250 genes in a bacterium such as *Escherichia coli*[27], and these appear to be of about 12 mμ in diameter or molecular weight about 750,000. Their number is not apparently likely to be more than, say, five times the value of 250; the much more complex *Drosophila* has only some 800 genes in its *X*-chromosome[27], and probably about 3,000 in all. In the bacterium the genes may thus constitute 0·1–1 per cent of the protein molecules. This is consistent with the balance suggested above between μmol. and mμmol. reactions.

Although the subject can be approached only tentatively, there is a further aspect of bacterial metabolism which requires assessing in relation to the suggested number of genes in a bacterial cell, and to the probability that a gene controls one biochemical step. A rough estimate of the number of reactions involved in autotrophic organisms in carbohydrate metabolism, synthesis of the amino-acids, simple peptides, lipoids, nucleic acids, and their constituents, and the vitamin-like compounds which are already known, gives a value of some 300 reactions. This makes no allowance for compounds as yet unidentified or not yet known to be general bacterial constituents; for the synthesis of specific proteins; or for arrangements necessary for assimilation and the avoidance of confusion between various intermediates in synthesis. Perhaps it may be supposed that many of the synthetic problems can be answered by suitable associations of the enzymes concerned, and that a reasonable proportion—say half—of bacterial constituents other than proteins are known. Then it still remains true that the number of reactions required for the purposes enumerated above, in nutritionally exacting organisms such as the β-hæmolytic streptococci, is less than that required in a non-exacting organism by a very considerable fraction. This makes understandable the development of nutritional needs in suitable environments, and the characterization of substances as vitamins[31].

Bacteria and other organisms. The degree to which the present suggestions concerning mμmol. processes can be extended to organisms other than bacteria is limited by the available data. Yeast cells and fungal spores are of some 50 to 250 $\times 10^{-13}$ gm. dry wt., but their rates of growth are slower than those of bacteria. With generation times of 3–6 hours, production of cells of similar vitamin content, but by means of the same number of enzyme molecules as in bacteria, would require the enzymes to exhibit 3 to 25 times the activity of those of the bacteria.

The difference between the rates of the reactions of Table 2 and those of Tables 1 and 3 suggest—though with much less security than in the case of bacteria—that certain such reactions may be due to only one or a few enzyme molecules per cell. Organisms such as Amœbæ or Paramecia, of 10^3 to 10^6 the volume of bacteria, are clearly beyond the scope of the present observations, even when the multiple nature of the nuclei of certain of them is taken into consideration. Indeed, differences in organisation would be expected to exist between organisms differing several thousandfold in magnitude. The present considerations suggest that these differences include the extension, to reactions with vitamin-like substances, of a mechanism by which one gene controls many enzyme molecules. One may query whether the relative simplicity and typical size of bacteria are related to the proportion of reactions they can carry out by enzymes which occur to the extent of one or a few molecules per cell, and which are closely related to the unit of inheritance.

Several reactions with vitamin-like compounds are carried out even by bacteria at high velocities; for example, the decomposition of nicotinic acid by a soil organism which derived its main energy and material from the compound[32]. This, if anything, serves to emphasize the similarity existing in the group of mμmol. reactions. The more rapid reactions, presumably involving control of many enzyme molecules by a given gene, are frequently adaptive, and suggest bacteria to possess the ability to transform a reaction of mμmol. to one of μmol. order, conceivably by proliferation comparable to that ascribed to the plasmagene. It must be emphasized in conclusion that to examine this and many other possibilities, much more information is required concerning the metabolism of vitamin-like compounds in bacteria.

Summary

Reactions in bacteria which take place at the rate of some mμmol./gm. dry wt./sec. may be due to one or a few molecules of catalyst per bacterial cell. They include some stages in the synthesis, breakdown and interconversion of many vitamin-like substances. Entities catalysing such reactions are likely to be closely related to the unit of inheritance. Many of these reactions are required for the progress of the more rapid cell reactions, such as respiration or fermentation, which proceed at the rate of some μmol./gm./sec. Also, progress of the first reactions can be conditioned by the occurrence of reactions of the second group. Reciprocal connexion is thus afforded between the sparsely distributed enzyme (and possibly the gene) and the synthesis of cell substance.

I have greatly appreciated the comments of Dr. D. G. Catcheside, Dr. M. Dixon, Prof. J. B. S. Haldane, and Prof. H. A. Krebs in the course of preparing this account.

[1] See symposium, *Ann. Missouri Bot. Garden*, **32**, 107 (1945), and Beadle, G. W., *Chem. Rev.*, 37, 15 (1945).

[2] Data (unless otherwise indicated) from Thompson, R. C., Univ. Texas Pub. No. 4237, 87 (1943), who grew the organisms at 33° in a medium containing glucose, a casein hydrolysate and inorganic salts.

[3] 10^{-13} gm. has been taken as a typical bacterial dry weight, based on the following values (derived from data of Bergey, D. H., "Handbook of Determinative Bacteriology" (Baillière, Tindall and Cox, London); Topley, W. W. C., and Wilson, G. S., "Principles of Bacteriology and Immunity" (Arnold, London, 1946); Buchanan, R. E., and Fulmer, E. I., "Physiology and Biochemistry of Bacteria" (Baillière, Tindall and Cox, London, 1928)) for organisms of Tables 1–3: *Aerobacter aerogenes*, 0·4–2, *Escherichia coli*, 1·1–1·7; *Proteus vulgaris*, 0·7–1·4; *Pseudomonas aeruginosa*, 0·6–1·2; *Hæmophilus parainfluenzæ*, 0·15–0·4; *Serratia marcescens*, 0·5–0·8; *Streptococcus pyogenes*, 0·15–0·45 × 10^{-12} gm. The probably multinuclear nature of certain of the organisms of the tables (cf Robinow, C F, in Dubos, R. J. "The Bacterial Cell" (Harvard University Press, 1945)) favours the conclusions of the present article

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[13] At 20°; Keilin, D., and Mann, T., *Proc. Roy. Soc.*, B, **125**, 187 (1938).

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[15] At 25°, assumed molecular weight, 10^5, Bucher, T., quoted from the printer's proof (received privately) of a paper sent for publication in the *Biochem Z.*, on June 29, 1944

[16] At 25°, Cori, C. F., Cori, G. T., and Green, A. A, *J. Biol Chem*, **151**, 39 (1943).

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[23] McIlwain, H., *Biochem. J.*, **39**, 279 (1945).

[24] At 37°; data from Hills, G. M., *Biochem. J.*, **37**, 418 (1943); for calculation see ref. 20.

[25] Turnover numbers for nicotinic acid derivatives during hydrogen transport by *H parainfluenzæ* and *Pr. vulgaris* can be calculated from data of Lwoff, A., and Lwoff, M., and of Morel, M. (see ref. 20), and yield values of 1 to 5 mol H_2/mol. nicotinic acid derivative/sec. Lwoff and Lwoff, however, consider experimental circumstances to render the bacterial activity artificially low.

[26] Average from Table 1 calculated by taking the mean value for each vitamin-like substance with different organisms, and averaging these values. This gives a value of 19 mol./mol./sec. with one hour as mean generation time; if this is supposed to be 20 min, the figure becomes 57 mol /mol./sec. Average from Table 3, 65 mol /mol /sec From Table 2, a simple average but excluding catalase and yeast polypeptidase: 560 mol./mol./sec.

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[30] McIlwain, H., ref. 20. The rates are there expressed in mμmol./mgm dry wt./hr. and the values thus differ from those of Table 3 by a factor of 3 6. Of the units available for expressing metabolic coefficients, the latter would seem preferable in being derived from the gram-mol, gram, and second, especially in calculations of the present type which involve comparison with turnover numbers already expressed with the minute or second as time-unit.

[31] cf. Fildes, P., *Proc. Roy. Soc. Med*, **28**, 79 (1934); Knight, B. C. J. G., Med. Res. Council Special Rep. Ser. No. 210 (1936); Lwoff, A., "L'Evolution Physiologique" (Paris, 1944).

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[33] The present considerations are relevant to only a few of the problems concerning the relative abundance of enzymes in cells. Pontecorvo (*Nature*, **157**, 95; 1946; and private communication) suggests that in most organism, all genes produce during the life-period of a cell a few molecules only of their primary products. The primary products of the genes are then considered to be capable of self-reproduction at rates specific to them, and so to condition the turnover per cell of reactions controlled by the genes. Enzymes occurring to the extent of only a few molecules per cell may then be regarded as an extreme case derived from products with very low rates of self-reproduction. This more general scheme tends to obscure the possibility that enzymes performing mμmol. reactions in bacteria may represent a simpler genetic process than those obtaining in other cases.

ISING'S THEORY OF BIRD ORIENTATION

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THE orientation of birds on migratory and homing flights still poses such baffling problems that the publication of an entirely new theory is a matter of exceptional importance to ornithologists. Critical experimental work on the homing of wild birds under conditions such that all guidance by previous knowledge of topography is ruled out, is still all too sparse. Nevertheless, evidence has for a long time been slowly accumulating that some species at any rate must possess powers of orientation independent of any terrestrial landmarks (see Griffin, 1944; review[1]); and more recently Rüppell[2] has added a further substantial piece of evidence for some 'sense of direction'. But what sensory mechanism could enable the bird to estimate correctly experimental displacement and maintain direction? For clearly any sensory equipment which is to meet fully the needs of the homing or migrating bird under adverse conditions, as when familiar landmarks are absent or obscured, must at least provide information with regard both to direction and latitude.

Prof. G. Ising, a distinguished Swedish geophysicist, has recently put forward[3] a new and highly original hypothesis on the sensory basis of direction-finding in animals, with special reference to problems of bird migration and homing. After pointing out the lack of evidence for, and the difficulties confronting, any magnetic theory of bird direction-finding, he proceeds to discuss the possibility that the perception of a Coriolis force, generated by the rotation of the earth, might provide the basis for an explanation. The Coriolis force may be described as follows. If a body is accelerated relative to the surface of the earth, the force per unit mass acting on it is not, as might be expected, numerically equal to the sum of this acceleration and the centrifugal acceleration due to the rotation of the earth, but contains a term in addition to these two. This term is equal to twice the product of the velocity relative to the surface of the earth, the angular velocity of the earth, and the sine of the angle between the direction of motion and the earth's spin axis. This 'extra' force is called the Coriolis force and is seen to vanish for zero velocity of motion over the earth's surface or if the body moves parallel to the earth's spin axis. For a full discussion of Coriolis forces see A. G. Webster's "Dynamics", 2nd edition, p. 317.

Prof. Ising has investigated theoretically the behaviour of liquid contained in a ring-shaped tube which is capable of being rotated relative to the spin axis of the earth. He shows that the Coriolis force produces two effects on the ring: first, a streaming movement in the fluid; and secondly, a couple acting on the ring. Both these effects have been verified in a semi-quantitative way in the laboratory with an apparatus having the ring 20 cm. in diameter. The energy involved in the two effects is of the same order. Ising's thesis is that these effects, alone or in combination, enable birds to determine their direction of flight and latitude; and he suggests that the semi-circular canals of the inner ear and their associated sense organs might be the structures by which the forces are perceived. Both effects are similarly dependent on latitude and on flight direction, but it is theoretically quite possible for the flying bird to disentangle these effects by periodic swinging movements of the head. From the physical point of view, therefore, there seems no great theoretical difficulty in regarding Coriolis forces as the basis for a latitudinal and directional sense in birds and other vertebrate animals.

Before, however, the theory can be accepted even provisionally, there remain to be considered practical and biological difficulties. The most important questions are: What is the magnitude of the forces involved, and what means has a bird of perceiving them? Ising shows that with a ring 1 cm. in diameter and 1 sq. mm. in cross-section, containing fluid of density 1 and zero viscosity, turning through 5·7° in the most favourable orientation will cause the fluid in the tube to gain a Coriolis energy of 2×10^{-13} ergs.

The bird would detect the motion by causing the kinetic energy of the liquid to be transmitted to some detecting apparatus such as the hairs of the crista or to the cupula (Lowenstein and Sand, 1940[4]). One must remember that each such hair has its own 2×10^{-14} ergs of Brownian agitation energy, per degree of freedom, and that there is, in Prof. Ising's model, a total of ten times this amount for distribution among the hairs per turning motion, even assuming a completely efficient energy transfer.

This crude picture of competition between the Coriolis energy and the Brownian energy needs modification in view of the fact that the bird can control to some extent the frequency spectrum of the Coriolis energy by changing the speed and nature of the head turning. So if the bird is differentially sensitive to the frequency of the displacement energy of the hair, the competition will not be between all the Coriolis energy and all the Brownian energy, but between those portions of them lying in the sensitive region. The bird may further gain by repetition of the swinging motion at a frequency lying in the sensitive region. Against all this we must set the fact that the most efficient transfer of energy from fluid to hair would take place when a large concentration of the Coriolis energy was in the frequencies near the natural frequencies of the hair, but that it is in these frequencies also that the greatest concentration of Brownian energy takes place. The net gain from these considerations cannot be estimated without accurate knowledge of the construction and elastic moduli of the hair; but it is improbable that it is high.

We must also inquire into the effect of changing the scale of the apparatus. It seems that the energy generated in the second effect is proportional to the seventh power of the linear dimensions of the ring, while in the first effect it is proportional to the sixth power. In consequence, a reduction in size by a factor of two would result in a hundredfold loss of energy generated. Thus if one were to take as criterion that the Coriolis energy must at least equal the Brownian agitation energy, the theory looks very unplausible for birds the semicircular canals of which are smaller than 1 cm. in diameter, although the detection of energy increments smaller than the Brownian energy is not impossible in principle.

The relative motion between the lymph and the wall of the canal, due, on the motion of the head, to the inertia and finite elastic properties of the system, cannot be estimated from the data at present available. But it must be borne in mind that this might well be of at least the same order as the motion due to the Coriolis forces.

Now, obviously, if this theory is indeed the basis of bird direction-finding, one would expect larger birds with larger semi-circular canals to be more efficient at long migration and homing flights than smaller birds. There is no suggestion that this is the case, though our present information on homing flights is too scanty to be of much value. Again, if the theory is true, one would expect the semi-circular canals of birds to be conspicuously large relative to the body size, compared with many other vertebrates; and moreover the canals should be relatively larger in small birds than in large ones. Here again the evidence is meagre, but the work of Retzius[5] gives a few readily accessible facts to go upon. Retzius describes and figures semi-circular canals of eleven species of birds. The accompanying table shows the maximum diameter in each case, expressed in cm., together with the weight in kgm. and wing-length in cm. of the female as given by O. Heinroth[6] and Witherby *et al.*[7] respectively.

It will be seen that while, as is the case with mammals (Prof. G. R. de Beer, personal communication), the canals of the smaller species are relatively larger than those of large species, the majority of birds have the canals well below 1 cm. in diameter; and many small birds which are far-flying migrants and expert homers obviously must have canals smaller still.

	Maximum diameter of semi-circular canals (cm.)	Body-weight, ♀ (kgm.)	Wing-length, ♀ (cm.)	Ratio of wing-length to canal diameter
Anser domesticus ..	0 82	3 0–3·5	41·6–46 8	55
Mergus merganser L. ..	0·79	1 40	25·0–26 7	32·7
Vanellus vulgaris, Bechst.	0 64	0 20	21 6–23 0	34·2
Scolopax rusticola L ..	0 64	0 27	18·4–20 8	30·6
Columba domestica .	0 59	0 30	21 0–22 2	36 6
Gallus domestica	0·64	1 50	—	—
Turdus musicus	0 465	0 07	11·1–12 1	24 3
Cypselus apus .	0 43	0·04	16 4–17 9	39 9
Nucifraga caryocatactes L.	0·64	—	17 5–19 0	28 4
Bubo ignavus, Forst	1·42	2 5–3 0	45 0–49 5	33 6
Haliætus albicilla .	1 29	5 0	61 0–68 5	50 0

In view of all these circumstances, we cannot avoid the conclusion that, sound and ingenious as the theory is from the point of view of the physicist, it encounters very great practical and biological difficulties. It does, however, serve to emphasize the need for repetition and extension of long-distance homing experiments critically controlled and on a much larger scale than hitherto. The design of many past homing experiments has been open to criticism in one way or another, but there seems little doubt that it should be possible to plan experiments which would put Ising's theory to the test.

[1] Griffin, D. R., *Quart. Rev. Biol.*, **19**, 15 (1944).
[2] Rüppell, *J. Orn. Lpz*, **92**, 106 (1944); see *Ibis*, **88**, 262 (1944)
[3] Ising, G., *Ark. Matematik, Astronomi och Fysik*, **32A**, N. 18, 1 (1945).
[4] Lowenstein, O., and Sand, A., *Proc. Roy. Soc*, B, **129**, 256 (1940).
[5] Retzius, "Das Gehörorgan der Wirbelthiere", **2** (Stockholm, 1885).
[6] Heinroth, O., *J. Orn. Lpz.*, **70**, 172 (1922).
[7] Witherby, H. F., *et al.*, "Handbook of British Birds" (1938–42).

OBITUARIES

Prof. Pierre Weiss

ALTHOUGH Prof. P. Weiss died so long ago as November 1940, there has been a lengthy interruption of the flow of scientific news from France Tribute to the great teacher and experimenter, whose influence dominated Continental magnetism for forty years, must of necessity be a little tardy.

Weiss was a true son of Alsace, being born at Mulhouse in 1865. Doubtless influenced by family connexions with industry, he began a four-years engineering course at Zurich in 1883. After this he entered the École Normale Supérieure, Paris, becoming *preparateur-assistant* there on the completion of his studies. Interest in magnetic problems had already been aroused by the work of Ewing. In 1895 Weiss took a lectureship at Rennes; and in the following year he presented his doctor's thesis at the Sorbonne, dealing with the properties of magnetite; then followed a move to Lyons, and in 1903 his appointment to the chair of physics at the Federal Polytechnic, Zurich. Already he had produced some twenty or so papers, including the classic ones on pyrrhotine.

The next few years, up to 1914, were Weiss's most productive, and accounted for more than sixty papers. In 1907, the fertile hypothesis of the molecular field and spontaneous magnetization was put forward. With Beck he investigated the relation between specific heat and molecular field for ferromagnetics. In 1910, Weiss spent a period in the laboratories of Kamerlingh Onnes; the influence of this period on the subsequent work of Weiss and his students is most apparent. In 1911 began the lengthy series of measurements of atomic magnetic moments leading to the introduction of a new unit, the Weiss or experimental magneton. Bohr's magneton is a fundamental unit with theoretical justification and, to within a fraction of 1 per cent, five times the Weiss unit. It is a measure of Weiss's enormous prestige that his experimental unit appears to have been preferred on the Continent up to the outbreak of the Second World War. Zurich before the First World War must have been particularly stimulating, with Einstein, Schrodinger, Ehrenfest, Debye, Piccard and Weiss shared between the University and Hochschule. Weiss always took pride in the fact that he was one of the small group that founded the Société Suisse de Physique, and that he was president up to 1914.

During the War, for about a year, Weiss was attached to the Direction des Inventions, Paris. With Cotton he devised a sound-ranging system for locating enemy artillery batteries. During 1916–18 he returned to his Zurich chair.

In 1918 came the call to assist with the building up again of the University of Strasbourg. No finer choice could have been made. In the Institut de Physique, electric light and central heating were quickly installed, the director's apartments were converted into laboratories, part of the basement was given over to accumulators, charging plant and switchgear. The building was wired to provide current for the electromagnets that the workshops made in addition to quantities of galvanometers, potentiometers and other apparatus. (Weiss's design of electromagnet is now standard equipment, and the Paris cyclotron magnet owes much to his interest and advice.)

The research programme of the Institute was divided up, magneto-optics to Ollivier, ferromagnetism to Forrer, paramagnetism to Foëx, X-radiography to Hocart, mathematical physics to Bauer, high-frequency work to Ribaud, to all of whom Weiss conveyed his enthusiasm. Every Monday all the research workers met for a session of "questions de l'ordre du jour". Weiss went to endless trouble at these meetings to help a worker finding honest difficulties; he went to similar trouble in rebuking a worker doing slovenly work or presenting it badly if he or she should have known better. Of particular joy to Weiss was the formation of a Strasbourg section of the Société de Physique française—the first of the provincial sections. There was but one choice for president. In the 1919–39 period Weiss continued his practice of shutting himself in the laboratory one or two days a week and being available to no one. Rather more than forty papers were produced in these years.

Large numbers of foreign workers came to the Institute, and Weiss was always most helpful and kindly to them, going out of his way to assure himself that they were comfortably housed, had sufficient money, and that all was well at their homes. The number of British students was small, but Rumanians and Poles came in plenty. Many of the workers were mature, being schoolmasters to whom the French *lycée* teaching programme afforded plenty of leisure. Weiss was a charming host, and there were many happy receptions held in the long wide corridor of the Institut de Physique following scientific meetings. Everyone met everyone, and not the least charming feature was the manner in which the other members of the Weiss family devoted themselves to putting everyone at ease. Weiss could chat readily in German (including Swiss, Alsatian and Mulhouse patois), Dutch and English besides his native French. Happy, and believing in the value of the work being accomplished in Alsace, Weiss declined advancement in Paris; in 1926 he had been elected a member of the Academy of Sciences. He was also doctor *honoris causa* of Geneva.

Weiss retired from the post of director at Strasbourg in October 1936, but continued to direct the magnetic laboratories until 1939, when the University was dispersed. Weiss himself went to Lyons, and, despite serious heart trouble, worked hard editing and translating papers presented to the International Magnetism Congress held in Strasbourg four months before the outbreak of war. In November 1940 he died in his seventy-sixth year.

I am indebted to Prof. G. Foëx, director of the Institut de Physique at Strasbourg, for furnishing me with some of the details mentioned.

C. R. S. MANDERS

WE regret to announce the following deaths:

Mr. F. W. Frohawk, well known for his illustrations of bird and insect life, on December 10, aged eighty-five.

Brigadier H. St. J. L. Winterbotham, C.B., C.M.G., D.S.O., formerly director-general of the Ordnance Survey, and recently general secretary of the International Geodetic and Geophysical Union, on December 10, aged sixty-eight.

NEWS and VIEWS

Crystallization of Synthetic Penicillin

THE recent announcement in *Science* (104, 431; November 8, 1946) that du Vigneaud, Carpenter, Holley, Livermore and Rachele have isolated the crystalline triethylammonium salt of synthetic penicillin-II, identical in all respects with the optically active triethylammonium salt of natural penicillin, has solved one more of the extraordinarily difficult series of problems that this remarkable substance has set. Readers will recall the statement on penicillin chemistry which appeared in *Nature* of December 29, 1945, p. 761, wherein an account was given of the co-operative effort of British and American chemists working under the auspices of the Medical Research Council (London) and of the Committee on Medical Research (Washington), and which will appear shortly in monograph form. During this highly successful essay in trans-Atlantic co-operation, chemists in the United States and in Britain were able to show that in the reaction between certain oxazolones bearing a potential aldehyde group and *d*-penicillamine, antibiotic activity corresponding to a 0·03 per cent yield of penicillin could be produced with regularity, and this could be raised to a 0·22 per cent yield under better conditions. This product, moreover, had a 'bacterial spectrum' similar to that of natural penicillin, and when isotopic 'tracer' technique was applied to the problem by use of penicillamine containing radioactive sulphur, the added natural penicillin was isolated as a triethylammonium salt which could be recrystallized repeatedly without sensible variation of its radioactive sulphur content. In addition, the presence of penicillin in the synthetic mixture was shown by its destruction by the enzyme penicillinase.

The use of partition chromatography by an American firm on the synthetic reaction mixture led to an active material containing 2·6 per cent of penicillin, while an application of the 'counter-current distribution' principle of Craig to this problem by du Vigneaud and his colleagues has raised the yield in one case to more than 16 per cent. The innate instability of penicillin frustrated efforts to fractionate such products, and it was only when the one-stage condensation process was modified to a two-stage process that a readily reproducible yield of activity could be obtained which proved thoroughly amenable to fractionation by the 'counter-current distribution' method. Eventually crystals of triethylammonium penicillin-II were obtained, identical in all respects with the corresponding salt of the natural product. Although use of *l*-penicillamine in the synthesis apparently leads to biologically inactive material, du Vigneaud and his colleagues have found that *d*-penicillamine can be replaced by *d*-cysteine, the thiolthreonines and β-mercaptoleucine with production of new penicillins which may possess different 'bacterial spectra'. It cannot yet be said that "what was only a path is now made a high-road", but the knowledge that is now being garnered with regard to the mechanism of the reaction involved in the two-stage synthesis may one day make it possible for synthetic penicillins to compete with the natural products.

Engineering at the City and Guilds College: Prof. E. F. D. Witchell

IN conferring the title of emeritus professor in mechanical engineering upon Edward Frank Dalby Witchell, the Senate of the University of London has signified its appreciation of a distinguished career in academic circles. His retirement severs a long and valued connexion with the University and with the City and Guilds College. After attending the City and Guilds College during 1898–1901 as a student in the Department of Mechanical Engineering, Witchell joined the staff of the College and eventually was appointed assistant professor and reader. His election as a member of the Institution of Mechanical Engineers and as president of the Association of University Teachers was followed by his appointment as professor in 1931, election as a fellow of the City and Guilds of London Institute in 1934 and appointment as deputy vice-chancellor of the University of London for 1945–46. His ability in debate and intimate knowledge of University procedure inevitably destined him to serve on the numerous academic boards, including the Board of the Faculty of Engineering, the Board of Studies in Civil and Mechanical Engineering and as its secretary for thirty-two years, the Academic Council and the Senate.

As a teacher, Witchell will long be remembered by many old students of the City and Guilds College for his clear and concise treatment of the subjects under discussion; his apparently effortless ability to explain fundamental principles, his fund of wit and sense of humour gave to his lectures a freshness that is rarely met in lecture theatres. It is among Old Centralians, perhaps, that his versatile qualities have been most freely displayed, and no small debt of gratitude is owed to him for the part he has taken in promoting social life between students, past and present, and inspiring the loyalty and devotion to the College that is characteristic of the Old Centralians.

Division of Colloid Chemistry, American Chemical Society Prof. C. Edmund Marshall

PROF. C. EDMUND MARSHALL, professor of soils at the University of Missouri, has been elected chairman of the Division of Colloid Chemistry of the American Chemical Society, in succession to Dr. Geoffrey E. Cunningham of the Dollinger Corporation, Rochester, N.Y. Other new officers of the Division are: Dr. Robert D. Vold (vice-chairman), of the University of Southern California; Dr. W. O. Milligan (secretary-treasurer), of the Rice Institute, Houston, Texas; Dr. E. A. Hauser, Massachusetts Institute of Technology; Dr. M. W. Tamele, of the Shell Development Company, Emeryville, Calif.; and Dr. J. W. Williams (chairman of the Symposium Committee), of the University of Wisconsin, Madison.

Prof. Marshall was born at Bredbury, Cheshire, on January 9, 1903, graduated from the University of Manchester and received the degree of M.Sc. for work on colloid chemistry. He was awarded a three-year research scholarship by the Ministry of Agriculture, and spent two years investigating the chemistry of humus at Rothamsted Experimental Station. The following year was spent in Prof. C. Wiegner's laboratory at Zurich, studying colloid chemistry and mineralogy. In 1928, he was appointed assistant lecturer in agricultural chemistry at the University of Leeds, where he started research in the colloid chemistry and mineralogy of soils and clays, which he has continued up to the present. In 1936, Dr Marshall was invited to become visiting associate professor of soils at the University of Missouri; he decided to remain there, and in 1941 was appointed professor of soils. He was elected president of the Soil Science Society of America this year.

Tycho Brahe Celebrations

THE University of Copenhagen celebrated the four hundredth anniversary on December 14 of the birth of Tycho Brahe (see *Nature*, December 14, p. 856), and honorary degrees were conferred on twelve astronomers from Denmark, Great Britain, Holland, Norway, Sweden, the United States and the U.S.S.R. The British representatives were Sir Harold Spencer Jones, Astronomer Royal, and Prof. F. J. M. Stratton, professor of astrophysics in the University of Cambridge.

A Century of Chemistry in Britain

As part of the centenary celebrations of the Chemical Society, an exhibition illustrating the achievements of British chemistry during the past century and the part which chemistry plays to-day in everyday life, organised by the Chemical Society and the Department of Scientific and Industrial Research, is to be held at the Science Museum, South Kensington, during July and August 1947. The Chemical Society is preparing the first part of the exhibition, which is to be historical in character, illustrating the great advances that have taken place during the hundred years of the Society's existence. How great are those advances will be noted when it is realized that, at the foundation of the Society, Dalton's atomic theory was but thirty years old; and the study of organic chemistry was in its infancy. Each branch of chemistry is under the care of a panel of experts who are now engaged in preparing an account of the progress in the past hundred years which this exhibition serves to illustrate. The Department of Scientific and Industrial Research is preparing a modern section dealing with the applications of chemistry to everyday life. Between the two parts of the exhibition there will be a linking section which will explain the processes by which the chemical engineer turns raw materials into the products which are familiar in the day-to-day life of every citizen. This will lead on to sub-sections dealing with such themes as textiles, agriculture, homes and buildings, roads and transport, fuel and power, health and food. The Department is having the co-operation of the Agricultural Research Council, various research associations and other organisations in the preparation of these exhibits; and the Central Office of Information is to be responsible for the design and layout of this part of the exhibition.

Aristotle's Views on Falling Bodies

ALVARO-ALBERTO has published an article (*An. Acad. Brasil. Ciencias*, 18, No. 1, March 31, 1946) which emphasizes a misunderstanding regarding the teaching of Aristotle on the velocities attained by falling bodies of different masses. It is often assumed that he taught that the velocity was proportional to the weight of the body, and that Galileo was the first to show the falsity of this assumption. A letter from J. F. Hardcastle which appeared in *Nature*, 92, 584, January 22, 1914, pointed out that Aristotle was referring to motion in a resisting medium, and that the velocity which he was considering was the terminal velocity. This velocity is attained when the force of resistance in the medium in which the body is moving is equal to the weight of the body. Greenhill had also a letter in the same issue, and in the following week Sir William Ramsay and Sir Oliver Lodge had letters which supported the point of view of Hardcastle and Greenhill. Hardcastle quotes from St. Thomas Aquinas's "Opera Omnia" (Leonine edition), which shows quite clearly that different media were considered by Aristotle—earth, air or water or other things—and if air is twice as 'subtile' as water, then for an equal distance the time of translation in water will be twice that in air. It may be added that the story, so often repeated, about Galileo dropping the weights from the Leaning Tower of Pisa close to the professors' heads as they came out from their lectures is now admitted, like some other stories about Galileo, to be apocryphal. Among these must be included the story that Galileo was the first to disprove the alleged statement of Aristotle about the velocities attained by falling bodies of different weights.

Lunar Auroras

Sky and Telescope of September contains a short note on this subject which deals with a suggestion made by Prof. Mohd. A. R. Khan, Hyderabad, in *Popular Astronomy* of June. This suggestion is that auroral phenomena would occur on the portion of the moon's surface that is lighted up by earthshine, should there be any appreciable atmosphere on our satellite. While it would not be possible to observe the auroral streamers, he suggests that a study of the spectrum of the earthshine on the moon might reveal the presence of the stronger of the forbidden lines of oxygen and nitrogen which are characteristic of auroras. Simultaneous spectra of neighbouring regions of the sky should also be obtained to avoid confusion between lunar and terrestrial auroral light. Prof. J. Kaplan, University of California, not only supports the suggestion but also enlarges upon it. He points out that direct photographs made with infra-red sensitive plates and filters would record the auroral band at 15,000 A. due to ionized nitrogen. Variations in such photographs would reveal the presence of the aurora ; they would require shorter exposure times, and would also be easier to obtain than the corresponding spectra.

The New Anatomy

CLASSICAL anatomy, the study of visible structure for structure's sake, has long since exhausted itself (and others). But a new generation of anatomists is showing us that, when morphological observations are correlated with parallel biochemical and biophysical analyses and with considerations of function, profitable advances may result, and that, handled in this way, anatomy has still much to contribute to biological science. Prof. J. Z. Young, in his inaugural lecture as professor of anatomy at University College, London, developed this theme and put forward some stimulating suggestions for future progress in anatomical research. He deplored the rigid departmental segregation of anatomists, physiologists, biochemists, pharmacologists and so on, which so usually exists in medical schools, and urged that all should regard themselves primarily as human biologists. Each worker must necessarily practise his own specialized technique; but he should endeavour to correlate his findings with those derived from other, and often widely differing, techniques, and so view his problem from all possible angles. Prof. Young's own work on the degeneration and regeneration of nerve, in which a correlation of histological with physico-chemical findings led to an entirely new concept of the nerve fibre, is a case in point. He gives a timely warning to biologists against a too mechanistic interpretation of their subject. Living structures show an organisation or pattern on a higher level than that ordinarily regarded as physical or chemical ; consequently a purely physical or chemical approach is generally inadequate for the total handling of a biological problem.

Another fact, often overlooked in our preoccupation with seeking to relate cause and effect, is that living systems exhibit a continuous and spontaneous activity of their own, which is the very essence of being 'alive', quite apart from any response which they may make to external stimuli or experimental manipulations. This is well seen in the case of the nervous system, where the concept of reflex action, which appeals so much to the 'cause and effect' mentality, has singularly failed to account for the more important features of higher nervous activity. In this connexion Prof. Young makes the interesting suggestion that the overall pattern of organisation of the neuropil, rather than the detailed point connexions of the individual fibres, might have some significance in the interpretation of higher nervous functions. The title of Prof. Young's address was "Patterns of Substance and Activity in the Nervous System" (London : H. K. Lewis and Co., Ltd., 1946. 1*s*. 6*d*. net). Following the tradition of his distinguished predecessors at University College, he is primarily interested in the nervous system, and he chose to illustrate his theme in that context ; but the theme is applicable to all biological inquiry, and his stimulating and thoughtful address will be widely welcomed, particularly by medical men of science.

Faculty of Science, Fouad I University

THE annual report for 1944–45 of the Faculty of Science, Fouad I University, Cairo, gives a brief indication of research work in progress, with lists of papers published and titles of theses for which degrees in science were awarded. In the Department of Applied Mathematics, R. H. Makkar has completed a thesis on "Series of Polynomials", and M. Tolba is investigating the question of two points expansion of functions, while in the Department of Applied Mathematics, Prof. M. A. Omara is engaged on determining the velocity potential of the fluid motion induced by a cylinder moving in an infinite mass of compressible fluid, and Dr. Hammad is still investigating the passage of sunlight through the atmosphere. In the Department of Physics, Prof. Fahmy has continued his work on the relativity of the electron and proton, in addition to supervising investigations on molecular polarization of vapours at different temperatures, electron polarization, electron diffraction and the viscosity of gases. Other work, under Dr. Mokhtar, has covered the scattering of supersonics, the measurement of absorption coefficients by acoustic materials and the tone qualities of musical instruments. The Meteorological Section has investigated matters connected with rainfall, sea-breezes, thunderstorms, floods in Egypt and north-east winds in the Nile Delta, while the Electronics Section has studied secondary emission, electron reflexion, X-ray analysis and Young's modulus.

In the Department of Botany, work on the anatomical determination of Pharaonic plant remains, carbohydrate and nitrogen metabolism, plant reactions to colchicine and β-indolylacetic acid, the effect of environmental factors on stomatal movements, the bacteriostatic effect of fungal metabolic products and organic chemicals and the ecology of Lake Edku are continuing; other investigations include a substitute colouring matter in butter, and the autecology of certain organisms. In the Department of Zoology, Prof. K. Mansour continued his study of some of the morphological and physiological aspects of the Lamellibrachiata (some of which have been reported in *Nature*), Prof. A. Naef his studies of the primitive Chordata, Dr. M. Waly his work of the Reptilia of Egypt and the fishes of the Nile, and Dr. F. Khalil the physiological investigation of the metabolism and excretion in some desert reptiles. Other investigations have covered the effect of triphenylchloroethylene on the development of the gonads of the frog, Egyptian spiders, the tympanic region of the Egyptian Insectivora, Chiroptera and Rodentia, yolk formation in the eggs of Mollusca, the chick embryo, etc. Work in the Department of Entomology has dealt with the biology of Egyptian insects, ecological studies of the insect fauna of freshwater ponds in the region of Cairo, and a biological and ecological survey of the Astero-lecaninæ. A note on the Library states that exchange activity with other universities and learned societies has now been resumed.

Francis Amory Septennial Prize of the American Academy of Arts and Sciences

UNDER the terms of a gift in the will of the late Francis Amory of Beverly, Massachusetts, the American Academy of Arts and Sciences offers a substantial prize for outstanding work on the alleviation or cure of diseases affecting the human reproductive organs. The gift provides a fund, the income of which may be awarded at seven-year intervals "as a prize and gold medal, or other token of honor or merit", to any individual or individuals for work of "extraordinary or exceptional merit" in this field. The next award is to be made in 1947. No formal applications and no essays or treatises from individuals are solicited; but suggestions will be welcome from any appropriate source that will be of aid to the Committee in making a wise selection. Recommendations may be addressed to Secretary, Amory Fund Committee, American Academy of Arts and Sciences, 28 Newbury Street, Boston, Massachusetts, U.S.A.

Institution of Civil Engineers: Awards

THE following medal, premiums and prizes of the Institution of Civil Engineers have been awarded for the papers mentioned, which have been discussed, or published without oral discussion, during the session 1945–46. *Baker Gold Medal:* G. L. Groves, in recognition of his work in connexion with the Ilford Tube. *Coopers Hill War Memorial Prize:* G. A. Maunsell, "Menai Bridge Reconstruction". *Telford Premiums:* K. C. Appleyard and G. Curry, "Opencast Coal Production in Wartime"; R. F. Wileman and H. W. Clark, "The Measurement of the Discharges of the River-basins of the White Nile (Sudan) and Nene (Great Britain)"; M. R. James, "Renewal and Extension of Pumping Machinery for the Metropolitan Water Board"; A. E. Reid and F. W. Sully, "The Construction of the King Feisal Bridge and the King Ghazi Bridge over the River Tigris at Baghdad"; J. N. McFeeters, "Concrete Runways"; J. K. Fisher, Alfred Goode and C. E. Docker, "Some Problems in the Design and Construction of Large Airfields"; J. D. Atkinson and George Cardiacos, "The Reconstruction of the Diyala Weir"; Robert Struthers and J. W. Lovatt, "Construction of a Heavy-Duty Concrete Runway"; Rudolph Glossop and A. W. Skempton, "Particle-size in Silts and Sands"; C. H. Dobbie, "Some Sea Defence Works for Reclaimed Lands". *Manby Premium:* Rowland Nicholas, "Highway Planning, with Particular Reference to Traffic Capacities". *Crampton Prize:* C. T. Mitchell, "Some Economical Aspects of Modern Earthmoving Equipment"; George Graham and F. R. Martin, "Heathrow. The Construction of High-grade Quality Concrete Paving for Modern Transport Aircraft". *Trevithick Premiums:* James Lorimer, "Some Uses of Explosives in Civil Engineering": A. H. Toms, "Repairs to Railway Viaduct over London Road, Brighton, after Damage by Enemy Action in May 1943". *Indian Premiums:* Sir Claude Inglis, "Training Works constructed in the Rupnarain River in Bengal—after Model Experiments—to Prevent Further Bank Erosion endangering the Bengal–Nagpur Railway Line Linking Calcutta with Bombay and Madras"; C. G. Sexton, "The Construction of the Coronation Bridge over the Tista River, North Bengal, India", Philip Claxton, "The Still-Water Pocket Principle".

The following Medal and Prizes have been awarded to students for papers read before local associations. *James Forest Medal and a Miller Prize:* O. H. Senogles, "The Superficial Geological Deposits of the Manchester Area" (North-Western Association, Manchester). *Miller Prizes:* F. N. Kirby, "The Development of the Parsons Steam-Turbine" (Newcastle-on-Tyne and District Association); J. A. Williams, "A Survey of Current Practice on the Design of Storm-water Overflow Works" (Newcastle-on-Tyne and District Association); Wilfred Eastwood, "Surface Water Drainage from Roads and under British Conditions" (Yorkshire Association); G. S. Glendinning, "Distribution of Rainfall and Run-off from Catchment Areas" (Edinburgh and District Association); T. E. H. Williams, "Bridge Construction with Special Reference to Foundations" (Birmingham and District Association); R. W. Winkler, "Repairs to an Early Nineteenth Century Sea Wall" (Edinburgh and District Association); G. F. Clark, "Timber Bridges—Various Types and Their Construction" (Edinburgh and District Association); D. D. Treharne, "Opencast Coal Production" (South Wales and Monmouthshire Association).

Announcements

THE honorary degree of D.Sc. has been conferred by the University of Oxford on Prof. H. C. Urey, professor of chemistry and director of nuclear research in the University of Chicago.

DR. F. DIXEY, director of geological surveys, Nigeria, has been appointed director of Colonial Geological Surveys, in which position he will be adviser on all geological matters to the Secretary of State for the Colonies.

DR. AUGUSTIN E. RIGGI has been appointed director of the Argentine (Bernardino Rivadavia) Museum of Natural Sciences at Buenos Aires.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Activation of Metallic Copper by Oxidation and Reduction

THE activation of copper by repeated oxidation and reduction is ascribed by previous authors to an increase in surface area[1], and our experiments have confirmed this conclusion. In the activated state, as measured by the interference colours produced during oxidation, the area is at least five to ten times as great as the measured area.

Copper oxide films on active metal, when reduced by hydrogen at 300° C., gradually lighten in colour as the reaction proceeds, but do not show interference colours. The reduction is evidently not simply a reversal of the process of oxidation. A marked feature of the reduction is an induction period during which the decrease in pressure of hydrogen is proportional to the square of the time. This indicates that metallic nuclei are produced at a number of active points and increase in diameter as the first power of the time. Separate nuclei cannot be seen, so that their number must be considerable. The extent of the growth of these nuclei is limited, probably because the film is finely subdivided by gaps in the material. Before the whole of the oxide is completely converted to metal, a second type of nucleation appears which is visible. These nuclei increase in diameter linearly with time, and this is believed to be due to the recrystallization of small copper nuclei by a process analogous to sintering, and also to those processes observed by Kornfeld[2] in the recrystallization of stretched aluminium wire. The recrystallization of the copper in a mixture of crystals of metallic copper and oxide may lead to the formation of inclusions of oxide in the resultant metal, and the phenomena observed by Ransley[3] during the reduction of oxide inclusions in metallic copper might be expected to occur.

Ransley showed that in the reduction of oxide inclusions in massive copper by hydrogen at 700–800° C., hydrogen diffused through the metal to the oxide, and water was produced at such high pressures that its escape caused cracks and blistering of the surface, producing the well-known embrittlement. A similar blistering has been observed during the activation of copper. Reduction of the inclusions by carbon monoxide did not occur by the same mechanism, since this gas, being insoluble in copper, cannot diffuse to the oxide. The reduction in this case took place, without embrittlement, by the diffusion of oxygen, possibly as ions, from the inclusions to the surface, where it reacted with the carbon monoxide. This difference between the mechanisms of the reactions of carbon monoxide and hydrogen is paralleled by their behaviour in experiments on the activation of copper.

If, after a series of reductions with hydrogen, carbon monoxide is used to reduce copper oxide, the rate for the first reduction is very similar to that with hydrogen. A second reduction following oxidation in the normal manner is, however, very slow and erratic, and cannot be completed at 300° C. in a reasonable time. The oxidation and reduction with hydrogen must be repeated before the carbon monoxide reduction goes smoothly. During the first reduction with carbon monoxide, the activation produced by hydrogen is very largely destroyed.

In the reduction of the oxide with carbon monoxide, metallic nuclei are formed very rapidly and in large numbers. In general, patches of metallic copper are formed on the surface long before reduction is complete. Under certain conditions, a complete covering of metal is formed on the oxide within a few minutes. The metallic film formed on the surface during the first reduction with carbon monoxide must be very porous, and the reaction continues because gas can diffuse to the oxide down numerous cracks in the metal.

The following sequence of events probably occurs during the reduction and oxidation reactions. During the reduction of the oxide by hydrogen, oxide particles will be enclosed in the metal which is formed. The reduction of these inclusions leads to embrittlement and the formation of a cracked metal film. This, it is suggested, is the process whereby the film is activated. This film expands on oxidation and the cracks are partly healed; but sufficient capillary passages remain to facilitate a subsequent reduction by hydrogen. However, after a carbon monoxide reduction, the metal film is much more compact, because embrittlement of the metal will not have taken place. Hence, on oxidation an oxide film is formed which is more perfect than when hydrogen is used. If a second reduction with carbon monoxide be now attempted, the film, being relatively free from cracks, is impermeable to the reducing gas, and the reaction is brought to a standstill.

These results indicate that there is some specific action by hydrogen which is absent when carbon monoxide is used, and is responsible for the activation of copper. This may be an effect analogous to that causing the embrittlement of massive copper on reduction with hydrogen.

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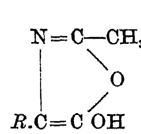
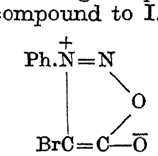
[1] Hinshelwood, *Proc. Roy. Soc.*, A, **102**, 318 (1922). Constable, *Proc Roy Soc*, A, **115**, 570 (1927); A, **107**, 278 (1925).
[2] Kornfeld, *Phys. Z. Sowjet Union*, **7**, 432 (1935); **12**, 301 (1937).
[3] Ransley, *J. Inst. Metals*, 65 (1939).

Structure of the Sydnones

THE communication from Prof. Wilson Baker and his collaborator[1] prompts us to intimate that we also have concerned ourselves with the sydnones, but from the point of view that their formation might be related to the racemization of α-acetylaminocarboxylic acids by acetic anhydride. Bergmann and Zervas[2] adduced evidence that this change depended on enolization of the anhydro-compound to I.


(I)


(II)

Accordingly, we have resolved N-nitroso-N-phenyl alanin by means of brucine, and from the *brucine salt*, m.p. 147–149°, less soluble in acetone or benzene, have prepared the *dextro-rotatory form* of the acid,

$[\alpha]_D = +68 \cdot 3°$. This is converted by acetic anhydride into the optically inactive N-phenyl-C-methylsydnone described by Earl and Mackney[3]. Also the rates of racemization and of sydnone formation by acetic anhydride in ethereal solution at the ordinary temperature are parallel. Furthermore, N-phenylsydnone exhibits its relationship to enols in that it undergoes instantaneous bromination in glacial acetic acid solution, yielding a *monobromo derivative*, m.p. 134°.

The structure (II) of this product follows from the fact that whereas hydrolysis by hydrochloric acid yields phenyl hydrazine hydrochloride, alkaline hydrolysis furnishes sodium benzene diazotate, identified by conversion into benzene-azo-β-naphthol.

This experimental evidence justifies the analogy quoted above, and is in line with the ideas expressed by Prof. Wilson Baker and W. D. Ollis.

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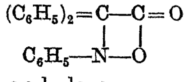
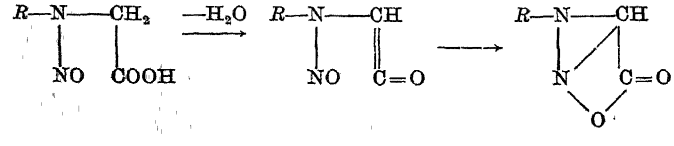
[1] *Nature*, **158**, 703 (1946).
[2] *Biochem Z.*, **203**, 280 (1928); compare Du Vigneaud and others, *J. Biol. Chem.*, **96**, 511 (1932); **98**, 295 (1932); **99**, 143 (1932).
[3] *J. Chem. Soc.*, 899 (1935).

THE fused-ring structure for the sydnones is as unacceptable to Prof. Wilson Baker and his colleague[1] as to Mr. Eade and myself. They suggest that since a reasonable structure of the classical type cannot be assigned to these substances, they are probably hybrids of some of the possible extreme dipolar structures, but they give no experimental evidence. The subject having been raised, it might be as well to indicate the lines on which we have done further experimental work.

N-Phenyl-C-phenyl-sydnone can be prepared by the action of acetic anhydride on a benzene solution of N-nitroso-α-anilinophenylacetic acid. If one of the optically active forms of the acid is used, the sydnone is inactive and identical with that prepared from the inactive acid. This was expected, but it is conceivable that racemization might not have occurred in building up the fused-ring structure. Further experimental evidence is available from the ready decomposition of N-phenylsydnone in boiling aqueous solution when a little sodium carbonate or sodium acetate is added. There is a rapid evolution of carbon dioxide and the formation of resinous products. This suggests an analogy with the decomposition of the products obtained when nitroso-compounds condense with ketenes. One of the two products formed from nitrosobenzene and diphenylketene

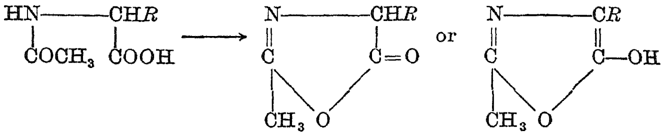


is very unstable and decomposes spontaneously to carbon dioxide and benzophenone anil[2]. It is conceivable that sydnone formation might involve the following steps



again leading to the unlikely bicyclic structure.

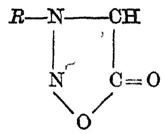
The similarity in behaviour of the carbonyl and nitroso groups suggests an analogy between the sydnones and the compounds formed by the action of excess of acetic anhydride on the α-acetylamino-carboxylic acids[3].



In this case there is no need to consider a possible bicyclic structure.

A further fact which must be considered in arriving at a satisfactory structure for the sydnones is the frequent occurrence of phenyl isocyanide among the decomposition products of N-phenyl-sydnone (for example, on its pyrolysis).

Taking all our present knowledge of the sydnones into consideration, I venture to suggest that we have in their structure a partly formed bond. There must always be a stage in the formation of a chemical bond between two reacting atoms in which they can be regarded as neither being uninfluenced by one another, nor in a state of complete and settled combination. It is usually not possible to arrest the process at this stage, but in the sydnones the five-membered ring controls the situation. The sydnones do not show any obvious dipolar characteristics, and if their structure is to be regarded as a hybrid of two dipolar structures, it may be merely one way of saying that there is present an incipient non-polar structure which one might write, *faute de mieux*,



the wavy line indicating an incipient link between the carbon and nitrogen. The same wavy line may have the further symbolism of indicating the doubt which must remain in our minds on this structural question until considerably more experimental evidence is forthcoming.

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Nov. 21.

[1] *Nature*, **158**, 703 (1946).
[2] Staudinger, "Die Ketene" (1912).
[3] Bergmann and Zervas, *Biochem. Z.*, **203**, 280 (1928).

Colorimetric Estimation of Penicillin II

THE Kapeller-Adler[1] method for the estimation of phenylalanine depends on the nitration of phenylalanine to give 3:4-dinitrophenylalanine; this is then reduced by alkaline hydroxylamine to a coloured nitroso derivative. It appeared probable that, by virtue of its phenylacetic radical, penicillin II (G) might be estimated in the same way and in the presence of penicillin I (F).

Unfortunately, nitrated samples of penicillin II treated with hydroxylamine gave colours varying from light straw to dark brown; these were unsuitable for colorimetric purposes. A trace of ethyl alcohol appeared to catalyse the nitration, but there was no improvement in the final colour. A modified procedure[2], in which the nitro derivative was reduced with powdered zinc and then coupled with sodium 1 : 2-naphthaquinone-4-sulphonate, gave no better results.

The most promising method was to combine the Kapeller-Adler nitration procedure with the diazotization technique introduced by Bratton and Marshall[3] for estimating sulphonamides. This depends on the nitration of the phenyl radical to a dinitro derivative, which is reduced with powdered zinc to form the corresponding diamine. After diazotization and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride, a mauve dye is formed and is suitable for colorimetric measurements. Preliminary experiments led to the adoption of the following procedure.

About 1 mgm. of sodium penicillin II was accurately weighed, placed in a small evaporating basin and treated with 2 ml. of a nitrating mixture (20 per cent potassium nitrate in concentrated sulphuric acid). The mixture was warmed on a steam bath for an hour and then diluted with 10 ml. of water. About 0·1 gm. of zinc was added and the heating continued for 15 min. more. After standing at room temperature for 15 min., the reduced solution was filtered through a No. 41 Whatman filter paper and made up to 20 ml. with distilled water. 3 ml. of this solution were shaken for 5 min. with 1 ml. of a 0·05 M solution of sodium nitrite and then mixed with 5 ml. of ethyl alcohol, followed by 1 ml. of 0·05 M N-(1-naphthyl)-ethylenediamine dihydrochloride. The coloured solution was made up to 10 ml. with distilled water and, after standing in the dark for 20 min., was examined on the Spekker photo-electric absorptiometer, using a No. 5 green filter (Chance Bros. O.G.1). A calibration curve was prepared by plotting the quantity of penicillin II used against the corresponding reading of the absorptiometer.

The calibration curves for phenylacetic acid and phenylalanine, which behaved in the same way as penicillin II, were approximately linear for quantities between 0·1 and 0·3 mgm.; over this range, the two curves could be almost superimposed on each other. The curve for sodium penicillin II was less steep and tended to flatten off much sooner. The coefficient of variation for the estimations was about 10 per cent.

As was to be expected, the reaction here described gives no colour when penicillin II is replaced by penicillin I. However, the method for penicillin II has only a limited field of application, for many aromatic compounds give a similar colour. Nevertheless, it is thought that the technique may be of value for estimation of penicillin II in 'purified' penicillin.

We wish to thank Mrs. A. C. T. Hickman for technical assistance.

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[2] Hess, W. C., and Sullivan, M. X., *Arch. Biochem.*, **5**, 165 (1944).
[3] Bratton, A. C., and Marshall, E K., *J. Biol. Chem.*, **128**, 537 (1939)

Test of a Cancerogenic Substance in Respect to the 'Non-disjunction' Frequency of the *X*-Chromosomes in *Drosophila*

SOME tests have been made with cancerogenic substances on *Drosophila* in respect to mutation frequency[1,2]. The results showed that the mutation-rate does not increase under treatment with cancerogenic chemicals.

We investigated the effect of benzpyrene on the non-disjunction frequency of the X-chromosomes in *Drosophila* females. We found mixing benzpyrene crystals with their standard food to be a convenient method of treatment. In this way one can trace the presence of the substance throughout the complete life-cycle by fluorescence microscopy.

The cultures were kept in darkness. The primary non-disjunction was investigated. We used 'bar' males and 'white' females from two inbred stocks which were kept pure for five years, and so may be considered as well-balanced stocks from the point of view of modifying factors. In this standard arrangement the frequency of exceptions was 1 : 500, or 0·2 ± 0·05 per cent without benzpyrene.

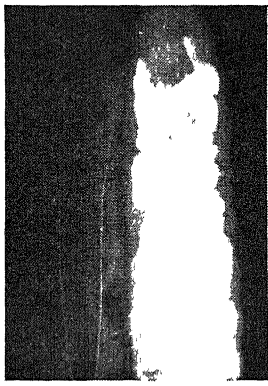

Fig. 1

Fig. 2

Fig 1. LARVÆ OF *Drosophila* TREATED WITH BENZPYRENE UNDER ULTRA-VIOLET LIGHT. A CONTROL IS SLIGHTLY ILLUMINATED BY ITS NEIGHBOUR

Fig 2. EGGS OF *Drosophila* FEMALE MAINTAINED ON FOOD CONTAINING BENZPYRENE UNDER ULTRA-VIOLET LIGHT. IN THE MIDDLE ARE THREE DARK CONTROLS

In the first test, the 'white/white' females were treated only during their larval life (Fig. 1). In this case benzpyrene was found in the ovaries of the females but not in the eggs when laid. There was not a significant difference between the control and the treated cultures in respect to the number of exceptional offspring.

In the succeeding test, the adult females were fed entirely on food containing benzpyrene, and in this

Treatment	Number of treated females	Offspring Reg. ♀	Ex. ♀	Reg. ♂	Ex. ♂	Total ex. (per cent)
In larval life (I)	24	1190	2	1096	7	0 39+0·13
In adult life (II)	10	1235	–	998	–	
	15	1290	2	1167	–	
	25	2525	2	2165	–	0·04+0·03
Controls	24	1075	2	1049	3	
	10	1466	5	1188	1	
	15	1470	1	1200	3	
	49	4011	8	3437	7	0·2+0·05

case, using the fluorescence microscope, we were convinced of the presence of the benzpyrene also in the eggs when laid (Fig. 2). In this test the ratio of exceptions was 1 : 2,300, or 0 04 ± 0·03 per cent. The standard errors showed a statistically significant difference (0·16 ± 0·059) in the negative direction between controls and the second test. None of the treatments used gave any detectable increase in the non-disjunction frequency; but treatment with benzpyrene decreased the number of exceptional flies, that is, the mutation-rate. The reason for this is not known, but perhaps such chemical agents in the egg help in separating the synapsed *X*-chromosomes, whereas, on the other hand, it is known that colchicine causes an increase of exceptional flies[3].

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Oct. 26.

[1] Auerbach, Ch., *Proc. Roy. Soc. Edin.*, **60**, 164
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[3] Gelei, G., and Csik, L., *Biol. Z.*, **60**, 275

Chemical Composition of *Rickettsia prowazeki*

THE chemical composition of the causative organism of epidemic typhus fever, *Rickettsia prowazeki*, is quite obscure. A chemical study was therefore undertaken of *Rickettsia* cultivated in the lungs of white mice, purified suspensions of which are used for the preparation of vaccines[1].

A batch of mice (1–2 thousand) was sacrificed 3–4 days after intranasal inoculation. Those lungs in which the rickettsiæ were most abundant were selected after morphological control. The suspensions of minced lungs prepared in physiological saline were subjected to prolonged differential centrifugation at 4,000 rev. per min. until a sediment of pure rickettsiæ was obtained, which were then washed four times with distilled water. 250 mgm. rickettsiæ was prepared from the whole, and this mass was analysed for lipoids, proteins, nucleic acid, carbohydrates and ash according to the methods used in the study of viruses[2]. After three-fold successive extraction with acetone, alcohol and ether, and subsequent solution in chloroform, 113 mgm. lipoids (46·6 per cent) was obtained. The lipoids were divided into two fractions, namely, neutral fat (29·7 per cent) and phospholipids (15·8 per cent). A separate sample was subjected to 2-hour hydrolysis in 2 *N* hydrochloric acid; this yielded 4·1 per cent carbohydrates (by the Hagedorn–Jenssen method, computed in glucose terms). The ash content was 3 per cent. The residue after extraction of lipoids was used for determination of protein and separation of nucleic acid. Direct determination gave 30·2 per cent protein, and in the residue (77 mgm.) after extraction of nucleic acid, 34·7 per cent. After a two-fold precipitation the yield of nucleic acid was 29 mgm. or 12 per cent. Nucleic acid gave a positive Feulgen reaction (see table).

The above data are of interest from several points of view. It will be noted that rickettsiæ are rich in lipoids, approaching in this respect animal viruses. The high content of lipoids accounts for ether treatment of rickettsiæ as proposed by Craigie for the preparation of vaccines. As to the high content of nucleic acids (12 per cent), this brings rickettsiæ close to bacteria. The fact that nucleic acid of rickettsiæ belongs to the type of thymonucleic acid is of great theoretical importance in connexion with nucleic acid metabolism in intracellular infection. The comparison of the chemical composition of rickettsiæ with that of viruses and bacteria suggests that, in this respect and in their cultural and biological properties, rickettsiæ occupy an intermediate position between bacteria and viruses.

CHEMICAL COMPOSITION OF *Rickettsia prowazeki* AS COMPARED WITH THAT OF BACTERIA AND VIRUSES

	Proteus vulgaris[3]	*Sarcina lutea*[3]	*Sporangium* sp.[3]	*Gonococcus*[4]	*Ricket. Prow.*	Influenza virus[5]	Encephalomyelitis virus[2]
Lipoids	11·5			10–14	46 6	42–48	45
Phospholipids	4 2				15 8		35
Neutr. fat	7 2				29 7		10
Protein	47 2	67 6	37·4	71–83	34 7	52–84	49
Nucleic acid	13 0	10 5	12 6	14	12 0	3 5	4
Carbohydrates	14 2	8·5		3 5	4 1		4
Ash				6–10	3 0	5–6	

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[6] Taylor, A., *J. Immun.*, **47** 261 (1943).

Man's Reaction to Mosquito Bites

IN reply to the query of Dr. Bristowe[1], variations in the attractiveness of different individuals to mosquitoes can be demonstrated in field experiments, which prove that whatever attracts mosquitoes can be measured quantitatively. Anophelines are readily deterred by minute quantities of pyrethrum[2], and in huts sprayed regularly random ingress is eliminated, and it then becomes possible to demonstrate their acute discrimination. In such huts I found that *c.* 250 per cent more females of *Anopheles funestus*, *A. gambiæ* and *A. melas* were attracted to three men than to one man, and by rotating sleeping duties I showed that over a period of three months one of the four men used was fairly consistently more attractive than any of the other three.

Of greater interest was the proof that there was considerable variation in the attractiveness of the same individual at different times. I obtained daily catches of *A. melas* from three Africans sleeping separately in experimental huts under close supervision. Individuals often became more attractive than their companions, and remained so every day for a week or so, then to return to normal. For example, the least attractive of these three men suddenly became most attractive for eight days out of nine, and in this period attracted 186 ♀ *A. melas*, while his nearest rival attracted only 77; during two successive days at the beginning of this period he attracted five times as many mosquitoes as either rival. Statistical analysis shows that these results are significant. De Meillon[3] showed that thorough de-odorization with soap and water considerably diminished attractiveness to *A. funestus*, but this factor seems insufficient to account for these results, which I consider to be due to variations in the physiological condition of the men.

It is likely that there are wide differences between the relative attractiveness of different individuals of different habits, but I know of no proved case of absolute immunity, and think that such claims are usually made by fortunate individuals who have escaped the more obvious consequences of mosquito bites and, therefore, erroneously concluded that they have never been bitten.

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[2] Ribbands, C. R., *Bull. Ent. Res.*, **37**, 163 (1946).
[3] De Meillon, B., *Pub. S. Afr. Inst. Med. Res.*, **6**, 323 (1935).

Anopheline Mosquitoes as Natural Vectors of Equine Dermal Filariasis

PAPADANIEL[1] has reported, under the name of 'gâle microfilarienne', a dermatosis affecting horses and mules in Greece. The disease is associated with the presence of microfilariæ in the skin lesions. Analogy with filariasis elsewhere would suggest that the infection is insect-borne. From the available literature it appears that the natural vectors in Greece have not previously been described.

In the course of an investigation by members of this Laboratory on malaria transmission in eastern Macedonia, developmental forms of filarial larvæ were observed in *Anopheles sacharovi* (var. *elutus*) and in *A. maculipennis* (var. *typicus*). Between July 24 and August 27, 1946, the total of mosquitoes dissected was 456, of which the majority were *A. sacharovi* and the remainder *A. maculipennis*. Filarial larvæ were found in fourteen *A. sacharovi* and in one *A. maculipennis* (var. *typicus*). The infection-rate in *A. sacharovi* was 3 per cent. The larvæ were recovered from the musculature of the mosquito thorax or neck, in numbers varying from one to eight per mosquito. In the fresh preparation, the larvæ were actively motile. The length varied from 0·9 mm. to 2·3 mm. and the diameter from 25 μ to 55 μ.

In the same series of dissections high plasmodial sporozoite and oocyst rates were recorded. In two specimens of *A. sacharovi*, simultaneous infection with filarial larvæ and plasmodial oocysts was observed.

Local human inhabitants showed a high incidence of malaria but no clinical evidence of filariasis. Fresh blood preparations taken from 95 persons by day and from 69 persons by night showed no microfilariæ. In addition, 30 specimens of venous blood, examined by Fülleborn's concentration technique[2], gave negative results.

Local mules were found heavily infected with microfilariæ. In this part of our investigation we were fortunate to have the assistance of Major S. Papadaniel, of the Greek Army Veterinary Corps. Examination of the exudate from skin lesions showed microfilariæ in large numbers. The length of these forms varied from 150 μ to 170 μ and the diameter from 3 μ to 4 μ.

Investigations are proceeding. Full details of the work will be submitted for publication elsewhere. Our thanks are due to Major J. C. W. MacFarlane and Sgt. J. Tait for their help with the venous blood examinations.

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[1] Papadaniel, *Ann. Méd. Vét.* (Oct. 1936).
[2] Fülleborn, "Handbuch der Pathogenen Mikroorganismen", 8 (1928).

Division of Labour in Ants

MODERN work on ant behaviour has shown that there is much greater individuality between one ant and another than was supposed. There is great variation in the individual psychology of ants: in their instincts, in their powers of learning, in their experience and their degrees of reaction to stimuli (see Schneirla, Chen, *et al.*[1]). This individuality reaches its highest development in the Formicinæ, where the social integration is also greatest—a fact which has appeared, to some people, surprising.

The basic integrating force of the ant community is that the offspring have experience of living mothers in their midst, while they themselves are sterile. The queens thus represent the shared fertility of the workers. This factor, coupled with the emotional bond of frequent mutual regurgitation, and the psychological and physiological similarity of the individual workers of the colony, leads to a most intimate mental and physical relationship.

Thus an ant reacts very quickly to the reaction of its neighbours; and when one ant responds to a stimulus, the other ants in close proximity to it are stimulated to similar reaction unless they are already reacting to a stronger stimulus, or their response to that particular stimulus is already fully satisfied.

The gesticulatory antennal communication system is an entirely adequate method of communication for the working of this method of the division of labour. One ant feeling hunger will leave the nest and forage, exciting other workers which it meets to do the same; another ant is stimulated to undertake the building operations required in another part of the nest, and similarly attracts other ants to that operation. These initial respondants to the stimuli are termed the 'excitement centres'[2].

The strength of the 'excitement centre' weakens as the operation nears completion or the reaction of the individual is satisfied, and eventually it fails completely. The operation will often be changed owing to the creation of a new stimulus: licking the larvæ may change to going out to forage if they show signs of hunger, or to moving them to a more humid chamber if they show signs of desiccation. The 'excitement centres' also function within the various operations causing the attraction and counter-attraction of ants between the various centres of activity.

Worker-polymorphism accounts for very little of the division of labour in ants, although the soldier reacts differently to stimuli from its fellow workers.

The mechanism of the division of labour depends on the reaction of the individual ant, and it is of considerable interest that in the ants the factors of individual variation in behaviour and social integration are complementary and not in conflict.

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[2] Wragge Morley, B. D., in the press.

Atmospheric Pressure Changes

THE pressure in the atmosphere at any point is determined by the weight of air above that point, so that pressure changes depend on the three-dimensional field of motion. The relation is normally expressed by the pressure-tendency equation:

$$\frac{\partial p}{\partial t} = -\int_z^\infty g \operatorname{div}(\rho\mathbf{v})\, dz,$$

where $\frac{\partial p}{\partial t}$ is the rate of change of pressure p at height z, g is the acceleration due to gravity, ρ the density, and $\mathbf{v}$ the wind vector.

It is customary to examine the pressure tendencies associated with certain theoretical approximations to the wind. The large divergence of the geostropic wind **J** when the latter has a north or south component has recently led Jeffreys[1] to recall the paradox that storms should move with a velocity comparable with that of sound unless they have a special, but unknown, kind of structure.

This is not the case, since there is in the atmosphere a natural brake mechanism which forces all pressure systems to move with relatively slow speeds. A good approximation to the wind is afforded by the gradient wind **G**, defined with its magnitude G by the equation

$$\mathbf{G}\left(1 - \frac{G\varkappa}{\lambda}\right) = \mathbf{J},$$

where $\varkappa$ is the curvature of the trajectory (positive in anticyclonic motion) and $\lambda = 2\omega \sin\varphi$, ω being the earth's angular velocity and φ the latitude. Making use of an expression due to Matthewman[2], the rate of change of pressure p associated with the gradient approximation is, very closely,

$$\frac{\partial p}{\partial t} = -\int_0^p \frac{1}{\lambda}\left\{\varkappa G\frac{\partial G}{\partial s} + G^2\frac{\partial \varkappa}{\partial s} - \frac{2\omega\cos\varphi}{r} v_G\right\} dp,$$

where $\frac{\partial}{\partial s}$ denotes space differentiation along the stream-line and v_G is the south-north component of **G**. r is the distance from the centre of the earth.

Each term on the right-hand side is potentially very large, and some further mechanism is required to explain why the observed pressure changes are invariably so small. In a non-steady pressure field, the trajectories of air particles differ from the instantaneous stream-lines. In order to show the mechanism of control, it is sufficient to represent this difference by

$$G(\varkappa - \varkappa_s) = C\varkappa_s \sin\theta$$

for a pressure system moving eastwards at speed C without distortion. The suffix s relates to the stream-line, and θ is the angle from which the gradient wind blows, measured clockwise from north.

The tendency equation then takes the form

$$\frac{\partial p}{\partial t} = -\frac{1}{\lambda}\int_0^p\Big[G\varkappa_s\frac{\partial G}{\partial s} + G(G + C\sin\theta)\frac{\partial \varkappa_s}{\partial s} - C\varkappa_s^2 v_G - \frac{2\omega\cos\varphi}{r}v_G\Big]dp$$

Now C is dependent on the pressure tendency itself, being, in fact, proportional to its local value. $\frac{\partial p}{\partial t}$ is, therefore, implicit on the right-hand side of the equation as well as explicit on the left, and one may effectively transpose the terms containing C by writing

$$F\frac{\partial p}{\partial t} = -\frac{1}{\lambda}\int_0^p\left(G\varkappa_s\frac{\partial G}{\partial s} + G^2\frac{\partial \varkappa_s}{\partial s} - \frac{2\omega\cos\varphi}{r}v_G\right)dp.$$

It is possible to assess the magnitude of all terms, including F, from synoptic charts of the free atmosphere. Alternatively, one may carry the theoretical work a stage further by examining the typical upper pressure distributions associated with the commonly observed surface pressure systems. A more detailed account of the theoretical work will appear elsewhere, by courtesy of the Director of the Meteorological Office, London.

The equation has been applied to schematic models of warm-sector depressions, cold depressions, warm anti-cyclones, cold high-pressure ridges, developing secondary depressions and frontal waves, and to systems of straight north-south isobars. In each case F may be represented explicitly in terms of the (vertically integrated) parameters of the pressure and stream-line fields. Its value is normally between 10 and 50 in middle latitudes, though it can be even higher: it may therefore be regarded as a control factor, and only a fraction of the large pressure tendencies suggested by the terms on the right-hand side of the above equations can in practice ever be realized.

The braking mechanism in the movement of pressure systems thus lies in the distortion of the trajectory which the movement itself creates. The normal movement of systems can be explained on the basis of the gradient wind approximation. (A discussion of this approximation is appended to the full paper.) By a refinement of the theory it is further possible to discriminate between fast- and slow-moving systems, and to show how the method is capable of yielding information on the development as well as the translation of the pressure system. Since only a contribution of the order of $25 \times \frac{\partial p}{\partial t}$ need be sought in examining the field of divergence, a much more hopeful outlook on the synoptic problem of pressure changes should emerge.

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Nov. 9.

[1] Jeffreys, H., *Quart. J. Roy. Met. Soc.*, 117 (Jan. 1946).

[2] Matthewman, A. G., *Phil. Mag.*, in the press.

Thickness Measurements of Thin Films

I READ with interest the description by Gunn and Scott[1] of their method of measuring the thickness of thin films. I have been using the same method for some time, but have found necessary a number of modifications and precautions which it may be helpful to record.

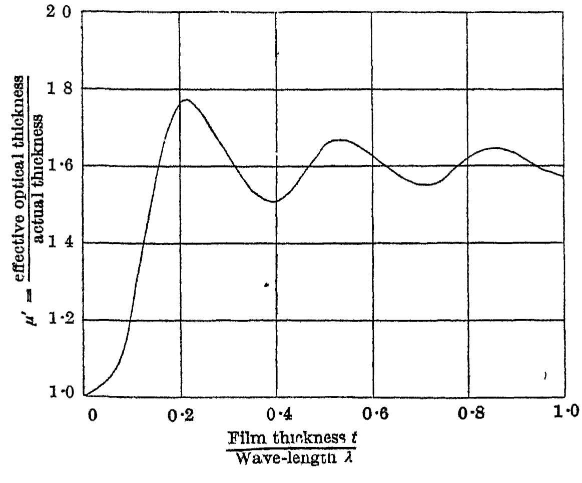
Gunn and Scott use multiple-beam wedge interference with monochromatic light between a reference surface and a slide on which the film is deposited. Silver is evaporated over the slide and the film, and at a film border the step corresponding to the film thickness gives rise to a displacement of the interference fringes. The method suffers from the slight disadvantage that in measuring the fringes with the travelling microscope a certain area of the slide is covered, and, therefore, if accurate figures are to be obtained the film must be uniform in thickness and the slide plane over this area. These requirements can be avoided if white light is used and the fringe system observed by means of a spectrometer. Other advantages, such as improved sharpness, of these 'fringes of equal chromatic order' are treated in detail by S. Tolansky[2] in another connexion.

The technique is to project an image of a line of the interference surfaces on to the slit of a spectrometer, the line crossing a film border. In this way the thickness at a single point of the film border is determined.

Inaccuracies in both methods arise due to the imperfect reflectivity of silver at visible wave-lengths. This causes the phase change upon reflexion to differ appreciably from 180°, and the equation governing interference must be written (normal incidence)

$$n\lambda = 2\mu t + 2\delta,$$

where δ takes account of the phase change. If a relative fringe displacement is to correspond to a change in optical thickness only, then δ must be constant. However, δ depends on the substance in front of the silver and, for semi-opaque silvering, also on the substance backing the silver. Therefore, in the case of interference with transmitted light an error will certainly be introduced due to the change in refractive index at the film border of the substance backing the silver; unless, indeed, the film under consideration has the same index as the glass supporting slide. Thus accurate measurement of film thickness is made possible only by having opaque silvering over glass and film, and using interference in reflexion rather than in transmission.



In measuring the optical thickness μt by depositing the film over the silvered glass slide, a similar error is introduced, of the order of 20 per cent in μ for a film 400 A. thick.

Another phenomenon in the measurement of refractive index is that the effective optical thickness, as determined by the interference method, is not μt for films less than about one wave-length thick but follows the curve shown, in which the effective refractive index $\mu' = \dfrac{\text{effective optical thickness}}{\text{actual thickness } t}$ is plotted against $\dfrac{\text{thickness } t}{\text{wave-length } \lambda}$ for a true refractive index of 1·6.

This curve has been deduced theoretically by the application of Maxwell's equations, but has also been verified by experiment.

It is seen that, owing to this effect and to the phase change on reflexion, large errors can be introduced in measurements on very thin films.

I am greatly indebted to K. Donaldson, a member of Dr. Tolansky's team at the University of Manchester, for introducing me to the technique and difficulties of multiple-beam interferometry.

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Nov. 14.

[1] Gunn, A. F., and Scott, R. A., *Nature*, **158**, 621 (1946).
[2] Tolansky, S., *J. Sci. Instr.*, **22**, 161 (1945).

Choice of a 'Reality Index' for Suspected Cyclic Variations

THERE are natural phenomena which, without being purely periodical in character, show cyclic variations with maxima of different height, minima of different depth and varying intervals between consecutive maxima or minima. While in many cases the cyclic variations are so strongly marked that there can be no doubt as to their reality, in other cases it might be difficult to decide whether the variations appearing in a series of observed quantities are of real significance or not. In the latter cases it would be advantageous if we could find a 'reality index' which would indicate the degree of reality of suspected cyclic variations in a similar manner as, for example, in the calculus of correlation the correlation coefficient expresses the degree of relationship between two sets of observed quantities.

In an earlier communication[1], I reported on a function which could be used as criterion for the reality of cyclic variations. This function is really the probability that the number of extrema actually found is less than the number which would be expected if the terms of the series were distributed at random. This criterion, however, has the following disadvantage: it holds good only for long cycles, but not for short ones. If, for example, in a sufficiently long series of observed numbers large numbers always alternate with small ones, the existence of a short-cycle variation is very probable. Thus the reality index should, in this case, have a value near 1; the above function, however, is zero in this case.

A more suitable reality index can be found by making use of an interesting investigation by W. O. Kermack and A. G. McKendrick[2]. These authors pointed out that, in an infinitely long series of quantities distributed at random, the mean length of a 'run' is 2·5, and that the standard deviation from this average is given by $S = \sqrt{\frac{3}{5r}}$, where r denotes the number of runs counted. By 'run' is meant either a sequence of decreasing terms beginning with a maximum and ending with a minimum, or a sequence of increasing terms beginning with a minimum and ending with a maximum; and by length of a run is meant the number of terms of which the run consists, the two extrema at the beginning and the end of the run being included. If the series is finite, the first run begins with the first term of the series and the last run ends with its last term, while all the other runs begin and end with extrema as stated above. In this case the mean length of a run (for random distribution) is less than 2·5; but if the series is not too short, the difference between 2·5 and the accurate mean length of a run can be neglected.

Consider a series of N observed quantities containing E extrema (that is, E terms which are either greater or less than both their neighbours). Then L, the observed average length of a run in this series, and r, the number of runs, obviously are given by $L = \frac{N+E}{E+1}$ and $r = E + 1$. If we put $D = L - 2{\cdot}5$, then, according to the results obtained by Kermack and McKendrick, a suitable reality index R should fulfil the following conditions:

(1) $R = 0$ for $D = 0$, (2) $R = 0{\cdot}5$ for $D = \pm S$,
(3) $R \to 1$ for $D \to \infty$, (4) $R \to 1$ for $S \to 0$ and $D \neq 0$.

Among all the functions satisfying these conditions it will, for practical purposes, be best to choose one for which the calculation is as easy as possible. I therefore propose to take

$$R = \frac{D^2}{D^2 + S^2},$$

as reality index for suspected cyclic variations. Then, values of R near 0 would refute the supposition of cyclic variations, values of R near 1 would point to their reality, while values of R near 0·5 would leave the question doubtful.

Sometimes it may happen that cyclic variations are covered by secondary fluctuations of an accidental character; these fluctuations may arise from errors of observation or may have their origin in the observed phenomenon itself. In this case it will be necessary to eliminate the secondary fluctuations by forming averages of the observed quantities in order to reveal the cyclic variations. An example will elucidate the application of the proposed reality index to a given series of observed quantities.

The heights of all sunspot maxima observed hitherto are characterized by the following Zurich numbers: 92·6, 86·5, 115·8, 158·5, 141·2, 49·2, 48·7, 71·7, 146·9, 131·6, 97·9, 140·5, 74·6, 87·9, 64·2, 105·4, 78 1, 119·2. This series consists of 18 terms, 11 of them being extrema. Thus we have $N = 18$ and $E = 11$; hence, $r = 12$, $S^2 = 0{\cdot}05$, $L = 2{\cdot}4$, $D = -0{\cdot}1$, $R = 0{\cdot}2$. (The value of R is given here only to one decimal place; for its more accurate calculation is impracticable because of the shortness of the series concerned.) The small value of R indicates no cyclic variation in the above series. This is interesting, because some authors have concluded from the sequence of seven alternating terms near the end of the series that high sunspot maxima generally alternate with low ones. This conclusion is incompatible with the small value of R.

Now take running averages of every four consecutive quantities of the above series. The resulting series is: 113 4, 125·5, 116·2, 99·4, 77·7, 79 1, 99·7, 112·0, 129·2, 111·2, 100·2, 91·8, 83·0, 83·9, 91·7. The number of terms has decreased to 15 and the number of extrema to 4. Thus $N = 15$ and $E = 4$; hence, $r = 5$, $S^2 = 0$ 12, $L = 3$ 8, $D = +1{\cdot}3$, $R = 0{\cdot}9$. This value of the reality index R is so near 1 that the existence of real cyclic variations is beyond question. But as the value of R for the original series was only 0·2, it is clear that the cyclic variations in the height of sunspot maxima are covered by secondary fluctuations.

I hope the reality index as proposed here will prove to be useful for the study of cyclic variations in many branches of science.

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Nov. 2.

[1] *Nature*, 157, 663 (1946)
[2] *Proc. Roy. Soc. Edin.*, 57, 228 (1936).

Mathematical Technology

THE new synthesis in mathematics discussed by Erdélyi and Todd and in the leading article in *Nature* of November 16 has had a long wait for explicit recognition. Ignored or sniffed at by 'real' mathematicians and, because of his natural tendency to mathematical irredentism, a worry to departmentalized institutions, the mathematical interpreter has for too long lurked in a scientific and administrative underworld. For that matter, there is no such thing, officially, as a 'mathematician'; he has to be described either as a teacher, a physicist, or a statistician, even if none of them.

There is as much permanent beauty in this branch of mathematics as in any other, for those who can recognize it. Essentially this new synthesis centres about what may be termed 'mathematics of organisation', and thus draws from material scattered all over the conventional mathematical 'subjects', as well as from subjects, such as the design of office forms and filing systems, the mathematical content of which is not derived from the dynamics of material systems, and is therefore classed as 'recreations' or 'trivia' in academic mathematics.

The controlling science of this interpretative mathematics is logic. The electrotechnical materialization of axiom systems has become known to most people recently; not only the theoretical foundations, but also day-to-day practice demand explicit knowledge of logic and scientific method. This necessity was pointed out to me some years ago by the late H. Glauert. He said, "If anybody brings you a differential equation to solve, find out the physical problem it is supposed to come from. Nine times out of ten it doesn't arise." Very rarely in technical work, and practically never in statistical work, is the question submitted the one that needs to be solved. Worse, the computational problem is usually submitted after the experiment has been done, and has been done to give answers to the wrong problem. The interpretative mathematician thus needs, besides technical qualifications, considerable powers of persuasion in order to discover what his client really needs.

Also it is almost essential that he should have worked in a cognate field of research, not as a mathematician.

The trouble is that scientific workers are never explicitly taught scientific method and argument. Even statistical techniques are taught without this foundation, and, therefore, often degenerate into a modern Pythagorian mysticism. It is noteworthy that, in my experience, the best junior computors are, *ceteris paribus*, not science but librarianship students. The course for librarianship includes those essentials of logic and classification that are essential in the intelligent operation of computing schedules, calculating machines and strategic computing installations of the punched card and electronic type. (Use of highly trained scientific or mathematical workers for whole-time computation is a waste of valuable skill.)

Inasmuch as we train scientific men to answer questions but not to ask them, we cannot complain if strategical computors are described as 'electronic brains'. The interpretative mathematician, by devising machinery to answer questions, is, with his colleague the technologist who devises machinery to perform actions, making it possible for human beings to live like human beings, instead of like machines, especially in clerical activities. He needs no apology, but he does need opportunity and facilities.

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Establishment of Cytochemical Techniques

IN 1936 there appeared an admirable book "Histochemie Animale", by L. Lison. In this book, Lison tried to teach chemistry to the histologists, and by the weight of his own reasoning he was forced to discard a great many time-honoured histological methods the validity of which had never been really investigated. Recently, in an article entitled "Establishment of Cytochemical Techniques"[1], J. F. Danielli endeavours to do a similar thing for cytochemistry, and, since some of his criticisms concern techniques which form the backbone of modern cytochemistry, it might, perhaps, be feared that his remarks will leave the cytochemist with a gloomy feeling of being suspended in mid-air without any reliable method to cling to. There is no doubt, however, that Dr. Danielli's plea for more exactness in cytochemistry is necessary and justified, and it is to be hoped that his article will have the same wholesome effect as Lison's book.

One of the points raised by Dr. Danielli concerns a technique which has been used at the Carlsberg Laboratory, and I should therefore like to add a few clarifying remarks. The principle involved is to stratify a cell by centrifugation, divide it and examine "the distribution of substances in the various fragments so obtained". This we have done in several cases[2,3], and we still believe that the conclusions drawn from these experiments are valid. Danielli's example of the untrustworthiness of the method concerns a case in which the respiration of the halves of sea-urchin eggs added up to more than the respiration of the intact egg. This, however, is concerned with the distribution of respiratory *activity*, and K. Linderstrøm-Lang and I have, for the very reason illustrated by this example, repeatedly stressed[4,5] the fact that the only conclusions to be drawn from experiments of this type are those based on the quantitative distribution of *substances*. In the case of an enzyme, as in our peptidase experiments, it is therefore necessary to kill the cell fragments, to remove diffusion difficulties by thorough cytolysis, to make sure of free contact between enzyme and substrate under conditions which are standardized for the enzyme determination, and to check that under these conditions the amount of enzyme found in the halves adds up to the value for the whole egg. If these provisions are made, we think that deductions are justified; but such deductions permit, of course, only *indirect* conclusions with regard to physiological activity.

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1 Danielli, J. F., *Nature*, 157, 755 (1946)
2 Philipson, T., *Compt rend. Lab. Carlsberg*, 20, No. 4 (1933).
3 Holter, H., *J Cell. and Comp. Physiol*, 8, 179 (1936).
4 Linderstrøm-Lang, K, *Compt rend. Lab Carlsberg*, 19, No. 13 (1932).
5 Linderstrøm-Lang, K, and Holter, H., *Ergeb. der Enzymforsch*, 3, 309 (1934) (see p. 311).

IT is most pleasing to read Dr. Holter's firm restatement of the basic principles which he and his colleagues at the Carlsberg Laboratory regard as essential in cytochemical studies by 'stratification' methods. We are completely in agreement on these points.

Most of the correspondence which has reached me on this matter has expressed agreement with the emphasis which I placed on the need for caution. Of the few dissentients, none has complained of feeling "suspended in mid-air"; nevertheless, I continue to hope that their position will ultimately become plain to them.

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Effect of Pressure on Crystal Growth

I HAVE been greatly interested in the comments arising from my suggestion that the expansion of setting plaster-of-Paris might be due to the pressure exerted by crystals of gypsum growing non-isotropically in a not completely confined space[1]. The original suggestion was speculative, and it was made clear that it had no direct experimental confirmation. Undoubtedly, more direct proof would be required before it is accepted. But in pure water or in solutions of accelerators, in which expansion is greatest, the rate of growth parallel to the *c*-axis is some 10–20 times greater than that perpendicular to the *c*-axis, and a considerable relative increase in solubility would be required to make the rate of growth parallel to the *c*-axis negligible compared with that perpendicular to it. It is not possible to express this in quantitative terms, or translate it into a force; but while experimental proof is lacking, the suggestion cannot be dismissed *a priori*, and is at least a possible explanation of a phenomenon for which no reasonable alternative is available.

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1 *Nature*, 158, 13, 584 (1946).

X-RAY ANALYSIS IN THE STEEL INDUSTRY

X-RAY analysis in the steel industry formed the subject of a conference organised by the X-Ray Analysis Group of the Institute of Physics, and held at Sheffield on November 8 and 9. Dr. W. H. Taylor presided over a well-attended meeting.

One of the main X-ray methods used in the study of the structure of steels and associated materials is that based on the Debye–Scherrer powder technique. The Conference opened appropriately with a paper by Dr. A. J. Bradley[1] on how to use this technique in problems requiring the highest possible accuracy in measurements of the intensity and position of the diffraction lines. Using specimens of thin annealed wires of platinum or copper in a powder camera of the Bradley–Jay type, he showed that it is possible to resolve the $K\alpha$ doublet for all lines of the diffraction pattern down to the smallest angle reflexions. With a good reflecting material, therefore, the technique is capable of giving very high standards of definition. Dr. Bradley then went on to consider the disturbing effects of such factors as height of the collimating slits, size and absorption of the specimen, and variations in the focal spot of the X-ray tube. He showed how they would influence the position and intensity of the diffraction lines, but gave formulæ for deducing the true values. He also drew comparisons between the photometer and the human eye as instruments for assessing the line positions and intensities. He finds that the photometric curve of a line is of the form $y = A/(B + x^2)$, when y is the height at a distance x from the peak; this, to a first approximation, gives a parabolic top to a line. He concludes that the blackening of a line as seen by eye is inversely proportional to the latus rectum of this parabola; also that the eye sees only the top and upper slopes of the lines, and sees the width of a line as the distance between those points where the curvature of the photometric record changes sign from the convex appearance at a peak to the concave appearance between peaks. He ended by showing how best to interpret both the visual and the photometric measurements.

Dr. G. W. Brindley, who opened a brief discussion, directed attention to the problem of estimating the proportions of materials in a mixture from the relative intensity of the lines from the individual constituents. He gave examples where the estimation could be very seriously in error because the particles were of different size and absorbing power.

The second paper was a contribution by Dr. W. A. Wood[2], on the application of X-rays to the study of internal stresses and deformation in iron and steel. The X-ray method for internal stresses, as first used, particularly in Germany, depended on measuring the lattice dimensions of a test piece in various directions, and treating the difference between these values and the normal unstressed lattice parameters as elastic strains, from which, with the aid of standard elasticity theory, the equivalent internal stresses could in principle be deduced. This early procedure was described at previous conferences. Dr. Wood therefore confined himself to a review of the method in the light of his work at the National Physical Laboratory on the changes in lattice dimensions and macrostructure of the metallic grain under known applied stresses. These researches showed that the early procedure must be used with caution. One reason is that the lattice stress-strain curves cease to follow Hooke's law when the primitive external elastic range of the steel is exceeded. This means that plastic deformation of itself results in permanent internal stresses which become superposed on the applied or macro-stress, and results in a residual lattice strain Another reason is that the extent of this residual strain remaining on removal of the stress differs for different crystallographic planes; therefore the early procedures for stress determination could lead to a different answer according to the particular planes used for measurement. Finally, since the magnitude of the residual strain associated with a given lattice plane depends on the previously applied stress, the stress-strain ratios, or apparent elastic moduli, have not the fixed values required by the simple procedures. Dr. Wood attributed these effects to the conditions associated with breakdown of the perfect grains of the primitive elastic range into the smaller disoriented crystallites produced during plastic deformation, and the fact that the X-rays examine only certain selections of these orientations. The breakdown is shown by the peripheral spread of the reflexion spots into continuous arcs along the diffraction rings; a lower limit to the crystallite size this produces is shown by the fact that later radial broadening of the diffraction ring reaches a steady value. In conclusion, Dr. Wood pointed out that although the use of the X-ray method calls for new discrimination, in particular the desirability of confining measurements to planes showing minimum residual strain and longest elastic ranges, at the same time it has brought to light previously unknown properties of the metallic lattice.

Mr. G. B. Greenough, in discussion, indicated that he had repeated the work of Dr. Wood and confirmed the presence of the internal strains produced in the plastic range. He gave figures for the residual strains of various planes in aluminium and magnesium as well as iron, and emphasized the point that whereas mechanical measurements take an average over all the grains, X-ray methods select grains of certain orientations, thus taking account of anisotropy. He also directed attention to the theories of Masing and Heyn on the production of internal stresses as the result of the irregularity in deformation of differently oriented grains in polycrystalline aggregates.

The third paper, by Mr. H. J. Goldschmidt[3], dealt with the application of X-rays to the study of electro-deposited layers of chromium on steel. Mr. Goldschmidt had examined the structural conditions associated with layers of high hardness and wear-resistance, and found that these properties are decided largely by the base metal and the conditions at the interface. In a good deposit, the electrolytic hydrogen enters the steel surface in the initial stages of deposition and expands the lattice to a size favourable for linking with the chromium eventually deposited. The linkage is metastable; and, after plating is finished, the tendency of the steel and the chromium to revert to their natural lattice dimensions leads to marked internal strains. Mr. Goldschmidt considers that these strains are the essential cause of the great hardness and wear-resistance. He has found that in poor-quality deposits no such linkage occurs, the iron and chromium lattices being separate. Mr. Goldschmidt has also applied the X-ray method to the study of the structural changes on annealing the samples up to 1,000° C., and distinguishes between three classes of occluded hydrogen according to the firmness of binding in the lattice. His points were illustrated by a number of interesting slides.

Dr. W. Betteridge, commenting on this paper, referred to results he has obtained in examination of thicker deposits of chromium. He believes that conditions at the interface would not influence the properties of the outer layers of a thick deposit. Dr. T. Ll. Richards considered that Goldschmidt's experiments explain the mechanism of adhesion rather than enhanced wear resistance and hardness. The explanation of these properties is not, however, one of the simpler problems confronting the X-ray worker.

The next paper introduced other difficult problems. This paper was by Dr. A. H. Jay[4] under the provocative title of his successes and failures in X-ray applications. He began with four failures. The first was lack of success in detecting the graphite in cast iron; this he attributed to the erosion of the graphite on preparing the cast iron surface and the formation of pits into which the incident X-rays did not sufficiently penetrate. The second was the failure to estimate the amount of silica in zircon flour to nearer than 2 per cent; a task, however, which, his hearers might have thought, would have been expected to be troublesome. The third was the difficulty of estimating quantitatively the constitution of iron ores, because some constituents, for example, goethite or limonite, gave such poor X-ray reflexions that they could be present to an appreciable amount and remain undetected. The fourth was the failure of X-rays to detect any difference of structure in a steel when it was in the tough condition and when it was in the 'temper brittle' condition. Dr. Jay then tempered the breeze by referring, though more briefly, to his successes. He quoted two: first, his establishing the difference in structure between steel in the tempered and the annealed condition, the former exhibiting partial recrystallization only of its constituents and the latter full recrystallization; secondly, a successful determination of the desirable chemical changes in refractory bricks during manufacture, and the light thrown on the mechanism of failure which might occur during firing. It is well known that he could have quoted others.

The Conference concluded with a paper by Prof. G. I. Finch on the rather different, but complementary, field of surface structure covered by electron diffraction. Prof. Finch[5] set out to show the type of problem to which this technique could be usefully applied, and illustrated his points by slides showing a fascinating series of electron diffraction patterns. He began by a group demonstrating the use of the technique for studying the degree of order of the atomic arrangement in a surface of thin film, the diffraction patterns ranging from the diffuse halo of the disordered state to the sharp rings or diffraction spots characteristic of crystallinity. He then illustrated his experiments on the Beilby layer associated with polished surfaces of metals and inorganic crystals, and demonstrated the interesting point that the amorphous layer, though undoubtedly produced during polishing, did not always persist as a disordered layer but might spontaneously crystallize to the structure of the substrate, particularly on well-defined cleavage planes. Prof. Finch ended by showing electron patterns obtained during his later researches on the mechanism of crystal growth and the manner in which minute crystals were influenced by the structure of the surface on which they were deposited. In conclusion, he certainly succeeded in making his hearers 'electron-diffraction conscious'.

W. A. Wood

[1] "The Intensity Relations of Debye–Scherrer Powder Diffraction Lines", A. J. Bradley.

[2] "The Application of X-Rays to Study of Internal Stresses and Deformation", W. A Wood.

[3] "An X-Ray Investigation of Electrodeposited Chromium", H. J Goldschmidt

[4] "Some Successes and Failures in the Application of X-Rays to Industrial Problems", A. H Jay.

[5] "The Surface Structure of Metals", G. I. Finch.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, NEW ZEALAND

ANNUAL REPORT

THE twentieth annual report of the Department of Scientific and Industrial Research, New Zealand, covers the year 1945–46 (Wellington: Gov. Printer. 2*s*.). Mr. D. E. Sullivan, Minister responsible for the Department, refers in his introductory statement to the way in which the Department has kept abreast of scientific developments overseas during the later years of the War, instancing the use of radar to assist coastal navigation and of antibiotics to assist the control of plant and animal diseases. The necessity of maintaining close personal contact with laboratories and research stations in other countries has led to a policy of sending young men of science abroad for varying periods to gain experience and provide a reserve of trained personnel to meet the increasing demand for scientific services. The secretary's report refers to the grouping of the Department's activities into the Auckland Industrial Development Laboratories, which has made good progress during the year. It is hoped that new activities sponsored in the Laboratories may ultimately be taken over by units of industry and serviced therefrom, leaving the Laboratories to concentrate on further research and development, and to undertake only such specialized services as are essential to industry and yet unlikely to be provided in New Zealand by private firms. It is also anticipated that the policy and organisation in relation to secondary industries of the Dominion Physical Laboratory, the Auckland Industrial Development Laboratories and the Defence Development Section, Christchurch, will do much to strengthen the link between research and secondary industries. During the year the Radio Development Laboratory and other sections in Wellington have been absorbed into the Dominion Physical Laboratory, and the chemical, physical and engineering activities have been grouped to meet more readily the requirements of the secondary industries.

During the year the Soil Bureau, Grasslands Division and Botany Division have combined in investigations covering areas where soil erosion is in progress or threatens. Over considerable parts of the Dominion the decrease of soil fertility through erosion can now be measured, and means for checking the losses indicated. The Grasslands and Botany Divisions have carried out surveys and initiated investigations, on hill country in both Islands, designed to conserve soil fertility. Other work of the Soil Bureau has covered soil chemistry, physics and biotics, while the Botany Division of the Plant Research Bureau has continued to investigate weed problems, some of which, such as nassella, constitute a serious threat to good pastoral land. The Grasslands Division continues to breed, test and multiply improved strains of grasses and clovers, while studies of the best utilization of these by the animal, direct and through conservation, as silage or hay, are proceeding. Similar investigations on arable supplementary fodder crops, both alone and in association with pastures, are in progress in the Agronomy Division, which also continues to produce high-quality seeds for certification. The Entomology Division has focused its attention on the grass-grub, the major insect pest affecting pastures, but has completed its study of the control of cheese-mites, in co-operation with the Dairy Research Institute, which established the value of dichloroethyl ether for this purpose. The Plant Diseases Division, in dealing with a wide range of diseases affecting crops, has included numerous trials of new insecticides such as D.D.T. and 'Gammexane' as well as investigations on proofing canvas, etc., against fungal attack and the control of moulds which stain plaster walls.

Much of the work of this Division has been carried out in collaboration with other divisions, for example, the Plant Chemistry Laboratory, where an investigation of the value of antibiotics for control of plant and animal diseases and the exploration of New Zealand flora for new strains has been initiated. The Plant Research Laboratory has also investigated hormone weed-killers such as 2 : 4-dichlorophenoxyacetic acid; while investigations by the Plant Diseases, Botany and Soil Survey Divisions of the yellow-leaf disease of *Phormium* (New Zealand 'flax') indicate that the disease occurs on soils where other plants suffer from mineral deficiency. The relation of phormium to shortages of trace elements is being examined, and the Botany Division has amassed much information on the management of phormium plantations which should be valuable in placing the industry on a sounder basis.

Work at the Wheat Research Institute has led to the breeding of a new high-protein wheat giving excellent baking quality, and the wheat and flour-testing services of the Institute have been used to keep damage to flour through unfavourable harvest conditions at a manageable level. A new milling machine devised by the Institute to give an 80 per cent extraction without loss of nutritive quality in the flour has proved satisfactory in commercial trials. Tobacco research has revealed a variety which possesses good resistance to black root-rot, a disease which is now appearing in certain types of soil, and promising results have been obtained in trials of a new type of curing-kiln conducted in collaboration with the Chemical Engineering Section of the Dominion Laboratory. Fertilizer experiments, nutritional studies and a soil survey of tobacco blends are other activities in this field.

Investigations under the Dairy Research Institute have included land-cress taint in cream and butter, the use of 'Parchfoil' and 'Pliofilm' for wrapping butter packed in *Pinus radiata* boxes, trials of a method of wrapping matured cheese in 'Pliofilm', the use of transparent wrapping materials for packing skim-milk powder and the formulation of a specification for parchment for wrapping butter. Final reports of the work on the effect of mastitis as indicated by the Hume modification of the bromthymol blue test on the composition and cheese-making properties of the milk have been forwarded for publication, and wor on starters for cheese manufacture, the cleaning o milking machines and on dairy cow nutrition ha continued. The Dairy Research Institute has als undertaken to compile, at the request of a committe on which the various other bodies, such as the Whea Research Institute, the Dominion Laboratory, th Plant Chemistry Laboratory and the Otago Medica School, also concerned with research on food fo human consumption, are represented, the informatior already in existence on the composition of the main classes of dairy produce. Fruit cold-storage research has continued on similar lines to those described in the previous report, and some notes are included on manurial investigations in the research orchard at Appleby, and other investigations under the Plant Diseases Division, Auckland, and the Cawthron Institute, Nelson.

The Industrial Psychology Division has completed its investigation into the attitudes and problems of the girl worker in industry, and a report is being published. Reports are also in preparation on social and welfare activities in industry and on an investigation on music in New Zealand factories. An investigation concerned with the personnel function of management in the smallish firms, with the view of ascertaining what techniques of management are meeting with success and the underlying attitudes of mind or philosophy, is in its initial stages. Surveys and investigations were carried out for nineteen firms and organisations, as well as vocational examinations involving the use of psychological tests for seven firms and one Government organisation. The New Zealand Leather and Shoe Research Association continued investigations on the quality of sole leather, the effect of perspiration on upper leather, and shoe comfort; and during the year a pilot drying plant suitable for the conveyor system of shoe manufacture was designed and erected. An investigation of the curing of calf-skins was commenced during the year.

The Manufacturers' Research Committee has no scientific or technical officers of its own, all industrial projects being carried out in departmental or research association laboratories, and as further trained staff and equipment become available it is hoped to extend the scientific services and testing organised under the Committee and available to the large number of small units in New Zealand which are unable to provide such facilities for themselves. In particular, it is hoped shortly to offer service in fuel technology. The Committee has during the year sponsored the formation of a research association for the pottery and ceramic industry. The Woollen Mills Research Association in its first year of work carried out many tests on unshrinkable finishes, and has studied laboratory methods of dyeing after-chrome blacks, as well as metachrome dye-baths in dye-houses, by means of pH measurements; it was discovered that under commercial conditions the use of ammonium sulphate was an unreliable method of neutralizing alkali in scoured wool or for controlling the pH of the dye-liquor. Tests have also been made of D.D.T. and 'Gammexane' for the protection of wool against carpet beetles.

In addition to the work of the Plant Research Bureau already noted, there may be mentioned its garden pea breeding work, maize-breeding project, linen flax investigations, studies of the toxicity to farm animals of indigenous and exotic plants, and on medicinal plants as well as seaweed investigations. Valuable work on different aspects of tomato production and on the use of small applications of cobalt sulphate for the control of bush sickness has been carried out at the Cawthron Institute. Research work at the Canterbury Agricultural College on the control of house-flies, on sheep dips, the pre-emergence decay of peas and, at the Massey Agricultural College, on plant propagation, drainage and the improvement of mutton and wool, is also noted in the report, which reviews further the activities of the Dominion Laboratory in physical chemistry, ceramics, paint and building research, chemical engineering, metals and corrosion, oil, bitumen and tar and coal survey. The work of the Dominion Observatory in time service and seismology continued on the usual lines, and that of the Dominion Physical Laboratory has been replanned in accordance with post-war needs.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, December 28

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. H. Hartridge, F.R.S.: "Colours and How We See Them" (Christmas Juvenile Lectures, 1).*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN FORENSIC MEDICINE AND TOXICOLOGY, and a LECTURER IN HYGIENE AND PUBLIC HEALTH—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2 (December 30).

ASSISTANT LECTURER (Grade IIb) IN MECHANICAL ENGINEERING—The Secretary, The University, Edmund Street, Birmingham 3 (December 31).

RESEARCH ASSISTANT, Milk Utilization Department, Auchincruive, Ayr—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (December 31).

DIRECTOR OF A PUBLIC HEALTH LABORATORY in the Southern Rhodesia Government Service—The High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (December 31).

READERSHIP IN GEOGRAPHY, and the READERSHIP IN GEOLOGY, tenable at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 31).

EDUCATIONAL PSYCHOLOGIST in the Ipswich Education Department—The Chief Education Officer, 17 Tower Street, Ipswich (December 31).

ENTOMOLOGIST to carry out fundamental research on bees, and a BIOLOGIST to assist in the research work of the Bee Research Department—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (December 31).

PROVINCIAL SUPERVISOR of the National Milk Testing Service in the Bristol province under the Ministry of Agriculture and Fisheries—The Advisory Bacteriologist, 22 Berkeley Square, Bristol 8 (December 31).

SENIOR LABORATORY TECHNICIAN IN THE DEPARTMENT OF PATHOLOGY at Broadgreen Hospital, Edge Lane Drive, Liverpool—The Medical Officer of Health, Hospitals Department, Gordon House, Belmont Grove, Liverpool 6, endorsed 'Laboratory Technicians' (December 31).

DEPUTY CITY ANALYST—The Medical Officer of Health, Public Health Department, Leeds, endorsed 'Deputy City Analyst' (January 3).

HEAD OF THE DEPARTMENT OF CHEMISTRY AND BIOLOGY—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (January 3).

LECTURER IN CHEMISTRY—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (January 6).

LECTURER IN THE DEPARTMENT OF ANIMAL HUSBANDRY, and a LECTURER IN BIOCHEMISTRY—The Bursar and Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (January 11).

METALLURGIST as Chief Officer of the Liaison and Technical Service Department—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1 (January 11).

PRINCIPAL SCIENTIFIC OFFICER in the Radar Research and Development Establishment of the Ministry of Supply—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1721 (January 13).

CHAIR OF GEOGRAPHY, tenable at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 14).

SENIOR ASSISTANT OBSERVER—The Director, The Observatory, Cambridge (January 15).

RESEARCH OFFICER, and an ASSISTANT RESEARCH OFFICER, in the Personnel Research section of the Leather Industries Research Institute, Rhodes University College, Grahamstown, South Africa—The Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, London, W.C.2 (January 17).

LECTURER (Grade I) IN THE DEPARTMENT OF CHEMISTRY—The Secretary, Royal Technical College, Glasgow (January 18).

CHAIR OF ELECTRICAL ENGINEERING, and a LECTURER IN MATHEMATICS, at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (January 31).

LECTURER IN ARCHITECTURAL CONSTRUCTION at Auckland University College, Auckland, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (January 31).

CHAIR OF MATHEMATICS tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 6).

OFFICIAL FELLOWSHIP IN CHEMISTRY—The Rector, Lincoln College, Oxford (February 8).

CHAIR OF PHYSIOLOGY—The Bursar, Royal Veterinary College, Royal College Street, London, N.W.1 (March 1).

CHEMIST AND BACTERIOLOGIST—The Chief Engineer, Mid-Wessex Water Company, Frimley Green, Aldershot, endorsed 'Chemist and Bacteriologist'.

CHIEF LABORATORY TECHNICIAN—The Medical Superintendent, Selly Oak Hospital, Birmingham.

DIRECTOR OF THE SOUTH AFRICAN FISHERIES RESEARCH INSTITUTE in Cape Town—The Scientific Liaison Officer, South Africa House, Trafalgar Square, London, W.C.2.

LECTURER IN MECHANICAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne.

PLANT BREEDER in the Hop Research Department—The Secretary, Wye College, Wye, Ashford, Kent.

DIRECTOR OF RESEARCH—The Secretary, Institute of Brewing, Goring Hotel, Grosvenor Gardens, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

International Committee for Bird Preservation (British Section). Annual Report for 1941–1945. Pp. 36. (London: International Committee for Bird Preservation, c/o Zoological Society, 1946.) [17

Carnegie United Kingdom Trust. Thirty-second Annual Report, 1945. Pp. viii + 44. (Dunfermline: Carnegie United Kingdom Trust, 1946.) [17

Empire Cotton Growing Corporation. Report of the Administrative Council of the Corporation, submitted to the Twenty-fifth Annual General Meeting on June 25th, 1946. Pp. ii + 22. (London: Empire Cotton Growing Corporation, 1946.) [17

Memoirs of the Cotton Research Station, Trinidad. Series A: Genetics, No. 26; (i) The Genetics of 'Corky'—(1) The New World Alleles and their Possible Role as an Interspecific Isolating Mechanism, by S. G. Stephens; (ii) The Crinkled Dwarf Allelomorph Series in the New World Cottons, by J. B. Hutchinson; (iii) Evidence on Chromosome Homology and Gene Homology in the Amphidiploid New World Cottons, by R. A. Silow. Pp. 54. (London: Empire Cotton Growing Corporation, 1946.) 2s. 6d. [17

Imperial Bureau of Soil Science. Technical Communication No. 43: Land Classification for Land-Use Planning. By G. V. Jacks. Pp. iii + 90. (Harpenden: Imperial Bureau of Soil Science, 1946.) 4s. [17

The Effects of the Atomic Bombs at Hiroshima and Nagasaki: Report of the British Mission to Japan. (Published for the Home Office and the Air Ministry.) Pp. vi + 22 + 24 plates. (London: H.M. Stationery Office, 1946.) 1s. net. [27

Nuffield Foundation. Report of the Trustees for the Three Years ending 31 March 1946. Pp. 64. (London: Nuffield Foundation, 1946.) [27

Broadcasting Policy. (Cmd. 6852.) Pp. 28. (London: H.M. Stationery Office, 1946.) 6d. net. [47

Department of Scientific and Industrial Research: Fuel Research. Survey Paper No. 58: Rapid Survey of Coal Reserves and Production: a First Appraisal of Results. Pp. viii + 24. (London: H.M. Stationery Office, 1946.) 9d. net. [167

Ministry of Health. Salaries of Whole-time Public Health Medical Officers: Interim Report of Askwith Memorandum. Pp. 12. (London: H.M. Stationery Office, 1946.) 2d. net. [167

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 586, Vol. 232: Smoking and Tobacco Pipes in New Guinea. By A. C. Haddon. Pp. 278 + 7 plates. (London: Cambridge University Press, 1946.) 50s. [167

Imperial Bureau of Plant Breeding and Genetics. The New Genetics in the Soviet Union. By P. S. Hudson and R. H. Richens. Pp. 88. (Cambridge: Imperial Bureau of Plant Breeding and Genetics, School of Agriculture, 1946.) 6s. [167

Proceedings of the Royal Society of Edinburgh, Section B (Biology). Vol. 62, Part 2, No. 24: The Use of Rats for Pressor Assays of Pituitary Extracts, with a Note on Response to Histamine and Adrenaline. By F. W. Landgrebe, M. H. I. Macaulay and H. Waring. Pp. 202–210. 1s. 6d. Vol. 62, Part 2, No. 25: Chemically Induced Mosaicism in *Drosophila melanogaster*. By Charlotte Auerbach. Pp. 211–222. 2s. Vol. 62, Part 2, No. 26: Situs Inversus Viscerum in a White Rat (*Mus norvegicus*). By Dr. R. A. R. Gresson. Pp. 223–224 + 1 plate. 6d. (Edinburgh and London: Oliver and Boyd, 1946.) [167

Royal Society of Edinburgh. Plant Invaders. By Sir William Wright Smith. (Address of the President at the Annual Statutory Meeting, October 22, 1945.) Pp. 8. (Edinburgh and London: Oliver and Boyd, 1946.) 1s. 3d. [167

University of Cambridge: Department of Colloid Science. A List of Papers published during 1912–46 under the direction of Eric Keightley Rideal, F.R.S., presented to him on his Resignation from the John Humphrey Plummer Professorship of Colloid Science, June 1946. Pp. 46. (Cambridge: Department of Colloid Science, The University, 1946.) [177

John Innes Horticultural Institution. Thirty-sixth Annual Report, 1945. Pp. 28. (London: John Innes Horticultural Institution, 1946.) [177

Institute of Social Medicine, Oxford. First Annual Report, 1945. Pp. 20. (Oxford: Institute of Social Medicine, 1946.) [177

College of the Pharmaceutical Society of Great Britain Annual Report for 1945 of the Research Departments. Pp. 20. (London: Pharmaceutical Society, 1946.) [177

List of Whole-time Awards for Scientific Research, other than Professorships, offered by Public and Private Bodies in Great Britain and Northern Ireland. Fourth issue. Pp. 36. (London: Royal Commission for the Exhibition of 1851, 1946.) 1*s*. [177

Other Countries

Skrifter udgivne af Kommissionen for Danmarks Fiskeri- og Havundersøgelser. No 11: Om Limfjordens Torskebestand. Af Erik M. Poulsen. Pp. 136. 4.50 kr. No. 12: Fiskeri- og Havundersøgelser ved Faerøerne. Af Å. Vedel Tåning. Pp. 127. 5.50 kr. No. 13: Havets Planteverden i økologisk og produktionsbiologisk Belysning. Af E. Steemann Nielsen. Pp. 108. n.p. (København: C. A. Reitzels Forlag, 1942–1944.) [17

Danish Review of Game Biology. Edited by Jagtraadets vildtbiologiske Undersøgelser. Vol. 1, Part 1: The Species of Capillaria parasitic in the Digestive Tract of Danish Gallinaceous and Anatine Game Birds. By Holger Madsen. Pp. iii + 112. (Copenhagen: J. H. Schultz, Ltd., 1945.) [17

Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Serie Hydrografi, Bind 3, Nr 2: The Influence of the Currents in the Danish Waters on the Surface Temperature in Winter, and on the Winter Temperature of the Air. By Aage J. C. Jensen. Pp. 52. Serie Hydrografi, Bind 3, Nr. 3: The Hydrography of the West Greenland Fishing Banks. By A. Kiilerich. Pp. 45 + 7 plates. Serie Plankton, Bind 3, Nr 4: Die Productions bedingungen des Phytoplanktons im Übergangsgebiet zwischen der Nord- und Ostsee. Von E. Steemann Nielsen. Pp 55. Serie Plankton, Bind 3, Nr. 5: Investigations on the Quantity and Distribution of Zooplankton in Icelandic Waters. By Poul Jespersen. Pp 77. Serie Plankton, Bind 3, Nr. 6: Über das Fruhlingsplankton bei Island und den Faroer-Inseln. Von E. Steemann Nielsen. Pp. 14. Serie Plankton, Bind 3, Nr. 7: Investigations on the Food of the Herring and of the Macroplankton in the Waters round the Faroes. By Poul Jespersen. Pp. 44. (København: C. A. Reitzels Forlag, 1940–1944.) [17

Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Serie Fiskeri, Bind 10, Nr. 7: Migration of Cod marked on the Spawning Places off the Faroes. By Å. Vadel Tåning. Pp. 52. Serie Fiskeri, Bind 11, Nr. 1: Survey of the Benthonic Animal Communities of Faxa Bay (Iceland). By Hermann Einarsson. Pp 46. Serie Fiskeri, Bind 11, Nr. 2: Contributions to the Biology of the Coalfish (*Gadus virens* L.) in Faroe Waters. By E. Bertelsen. Pp. 68. Serie Fiskeri, Bind 11, Nr. 3: Experiments on Meristic and other Characters in Fishes, 1. By Å. Vadel Tåning. Pp. 66. (København: C. A. Reitzels Forlag, 1940–1944.) [17

Carlsberg Foundation's Oceanographical Expedition round the World 1928–30 and previous *Dana* Expeditions under the Leadership of the late Prof. Johannes Schmidt. *Dana* Report No. 18: Die Scyphomedusen. Von G. Stiasny. Pp. 29 + 2 plates. 3.50 kr.; 3*s*. *Dana* Report No 19: Mysidacea–Lophogastrida, 1. Par Prof. Louis Fage. Pp 52. 7.50 kr.; 6*s*. *Dana* Report No. 20: Les Gymnosomes, 1. Par A. Pruvot-Fol. Pp. 54. 7.50 kr.; 6*s*. *Dana* Report No. 21: A Study of a Collection of the Fish *Schindleria* from South Pacific Waters. By Anton Fr. Bruun. Pp 12. 1.20 kr., 1*s*. *Dana* Report No. 22: Indo-Pacific Leptocephalids of the Genus *Anguilla*; Systematic and Biological Studies. By Poul Jespersen. Pp 128 + 4 plates. 24 kr.; 20*s*. (Copenhagen: C. A. Reitzels Forlag, London: Oxford University Press, 1940–1942.) [17

Carlsberg Foundation's Oceanographical Expedition round the World 1928–30 and previous *Dana* Expeditions under the Leadership of the late Prof. Johannes Schmidt. *Dana* Report No. 23: Mysidacea–Lophogastrida, 2. Par Prof. Louis Fage. Pp. 67. 11 kr.; 9*s*. *Dana* Report No. 24: The Biology of *Spirula spirula* (L.). By Anton Fr. Bruun. Pp. 46 + 2 plates. 10 kr.; 8*s*. *Dana* Report No. 25: Über *Nebaliopsis typica* G. O. Sars nebst einigen allgemeinen Bemerkungen uber die Leptostraken. Von Folke Linder. Pp. 38 + 1 plate. 10 kr.; 8*s*. *Dana* Report No 26: List of Supplementary Pelagic Stations in the Pacific Ocean and the Atlantic. By Å. Vedel Tåning. Pp. 15. 5 kr.; 4*s*. *Dana* Report No. 27: Euphausiacea, 1, Northern Atlantic Species. By Hermann Einarsson. Pp. 185. 30 kr.; 25*s*. (Copenhagen: C. A. Reitzels Forlag, London: Oxford University Press, 1942–1945.) [17

Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Serie Hydrografi, Bind 3, Nr. 4: Drift-Bottle Experiments in the Northern North Atlantic. By Frede Hermann and Helge Thomsen. Pp 87 + 4 plates. (København: C. A. Reitzels Forlag, 1946.) [167

Institute of Theoretical Astronomy of the Academy of Sciences of the U.S.S.R. Ephemerides for the Determination of Time Corrections by Equal Altitudes (Zinger's Method) for 1946. 21st Year. Pp. 101. (Moscow and Leningrad: Academy of Sciences Press, 1945.) 10.50 roubles. [167

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Band 23, No. 3: On the Genus *Peltostega* Wiman and the Classification of the Triassic Stegocephaliens. By Tage Nilsson. Pp. 55. Serien 3, Band 23, No. 2: On the Proper Motions of Stars and the Absorption of Light in the Region of the Open Cluster Messier 52. By Arne Lundby. Pp. 63. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: H. K. Lewis and Co., Ltd., 1946.) [167

Ministério da Agricultura: Serviço florestal, Seção de botânica. Boletim No. 1: Chaves para a determinação de gêneros indígenas e exóticos das dicotiledôneas no Brasil. Vol. 1: 1217 gêneros de 152 famílias. Por Liberato Joaquim Barroso. 2a edição. Pp. 272 (27 plates.) (Rio de Janeiro: Ministério da Agricultura, 1946.) [167

Development and Welfare in the West Indies. Bulletin No. 21: The Fisheries of British Honduras. Report by Dr. Ernest F. Thompson. Pp. 32. (Bridgetown: Advocate Co., Ltd., 1946.) 10 cents. [167

State of Connecticut Public Document No 24. Sixty-fifth Report of the Connecticut Agricultural Experiment Station for the Year 1941. Pp. iii + 768 + 78. (New Haven, Conn.: Connecticut Agricultural Experiment Station, 1941.) [177

Connecticut Agricultural Experiment Station. Bulletin 430: Commercial Fertilizers; Report for 1939. By E. M. Bailey. Pp. 63. Bulletin 431: Tetranychidae of Connecticut. By Philip Garman. Pp 63–88. Bulletin 432: Diseases and Decays of Connecticut Tobacco. By P. J. Anderson. Pp 89–162. Bulletin 433: Tobacco Substation at Windsor; Report for 1939. By P. J. Anderson, T. R. Swanback and O. E. Street. Pp. 163–210. Bulletin 434: Connecticut State Entomologist; Thirty-ninth Report, 1939. By Dr R. B. Friend. Pp. 211–322. Bulletin 435: The Improvement of Naturally Cross-Pollinated Plants by Selection in Self-Fertilized Lines, 3, Investigations with Vegetatively Propagated Fruits. By Donald F. Jones and W. Ralph Singleton. Pp. 323–348. Bulletin 436: Commercial Feeding Stuffs, Report on Inspection, 1939. By E. M. Bailey. Pp. 349–450. Bulletin 437: The Forty-fourth Report on Food Products and the Thirty-second Report on Drug Products, 1939. By E. M. Bailey. Pp 451–486. Bulletin 438: Annual Report for the Year ending October 31, 1939. Pp 487–552. Bulletin 439: Soil Management for Intensive Vegetable Production on Sandy Connecticut Valley Land. By M. F. Morgan and H. G. M. Jacobson. Pp 553–592. Bulletin 440: The Biology of *Anasa tristis* DeGeer, with particular reference to the Tachinid Parasite, *Trichopoda pennipes* Fabr. By Raimon L. Beard. Pp. 593–686. (New Haven, Conn.: Connecticut Agricultural Experiment Station, 1939–1940.) [177

Connecticut Agricultural Experiment Station. Bulletin 441: Commercial Fertilizers, Report for 1940. By E. M. Bailey. Pp. 60. Bulletin 442: Chemical Investigations of the Tobacco Plant, 8, The Effect upon the Composition of the Tobacco Plant of the Form in which Nitrogen is Supplied. By Hubert Bradford Vickery, George W. Pucher, Alfred J. Wakeman and Charles S. Leavenworth. Pp. 61–120. Bulletin 443: Commercial Feeding Stuffs, Report on Inspection, 1940. By E. M. Bailey. Pp 121–222. Bulletin 444: Tobacco Substation at Windsor; Report for 1940. By P. J. Anderson, T. R. Swanback and S. B. LeCompte, Jr. Pp. 223–286. Bulletin 445: Connecticut State Entomologist; Fortieth Report, 1940. By Dr. R. B. Friend. Pp 287–384. Bulletin 446: Annual Report for the Year ending October 31, 1940. Pp. 385–446. Bulletin 447: The Forty-fifth Report on Food Products and the Thirty-third Report on Drug Products, 1940. By E. M. Bailey. Pp 447–482. Bulletin 448: A Portable Charcoal Kiln, using the Chimney Principle. By A. Richard Olson and Henry W. Hicock. Pp. 483–514. Bulletin 449: Forest Lysimeter Studies under Hardwoods. By Herbert A. Lunt. Pp. 515–572. Bulletin 450: Chemical Soil Diagnosis by the Universal Soil Testing System. By M. F. Morgan. (A revision of Bulletin 392.) Pp. 573–630 + 8 plates. Bulletin 451: Role of the Dosage-Response Curve in the Evaluation of Fungicides. By Albert E. Dimond, James G. Horsfall, J. W. Heuberger and E. M. Stoddard. Pp. 631–668. (New Haven, Conn.: Connecticut Agricultural Experiment Station, 1940–1941.) [177

Connecticut Agricultural Experiment Station. Circular 137: The Shelton and Hebron Strawberries. By D. F. Jones and W. R. Singleton. Pp 4. Circular 138: Early Sweet Corn Hybrids, Spancross, Marcross and Carmelcross. By W. R. Singleton and D. F. Jones. Pp. 5–12. Circular 139: Turf Management. By M. F. Morgan, E. M. Stoddard and J. P. Johnson. Pp. 13–28. Circular 140: Oriental Fruit Moth Parasites. By Philip Garman. Pp. 29–48. Circular 141: Laws and Regulations concerning the Inspection of Nurseries in Connecticut and Transportation of Nursery Stock. Compiled by R. B. Friend and M. P. Zappe. Pp. 49–84. Circular 142: Peat and Swamp Muck for Soil Improvement in Connecticut. By M. F. Morgan. Pp. 85–96. (New Haven, Conn.: Connecticut Agricultural Experiment Station, 1939–1940.) [177

Connecticut Agricultural Experiment Station. Circular 143: Control of the Pear Psylla in Connecticut. By Philip Garman and J. F. Townsend. Pp 12. Circular 144: Control of the European Corn Borer by Sprays and Dusts. By Neely Turner. Pp. 13–16. Circular 145: Control of the Apple Maggot. By Philip Garman. Pp 17–26. Circular 146: Loams for Top-dressing. By Herbert A. Lunt. Pp. 27–34. Circular 147: Control of the European Corn Borer by Sprays and Dusts. By Neely Turner. Pp. 35–44. Circular 148: Sweet Corn Hybrids, Lexington, Lincoln and Lee. By W. R. Singleton and D. F. Jones. Pp. 45–52. Circular 149: Herbs and their Culture. By Ruth M. Hendrickson and Frances M. Johnson. Pp. 53–72. (New Haven, Conn.: Connecticut Agricultural Experiment Station, 1941.) [177

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SCIENTIFIC AND TECHNICAL BOOKS

ALTHOUGH in his pamphlet, "Newsprint—a Problem for Democracy", Sir Walter Layton was concerned more specifically with the consequences of the reduction in size and freedom of circulation of newspapers, the position he discloses is not without relevance to the scientific and technical Press. Scientific and technical periodicals may also be described as imported articles, being like the newspaper printed either on imported newsprint or on newsprint made in British mills from imported pulp, and they are equally vulnerable to any factor interfering with imports. Similarly, scientific work and interests, as much as knowledge of public affairs, have suffered from the compression and also from the selection that are inevitable when newspapers are confined to four pages. Matters of scientific and technical importance raised or debated in either House of Parliament, for example, are frequently unreported or at best receive bare mention in the daily Press ; the scientific and technical Press can rarely afford the space to discuss the topic adequately, and sometimes it is overlooked entirely. Some attempt is made by the Parliamentary and Scientific Committee in *Science in Parliament* to remedy this position, but the summaries thus published are usually too belated for any effective action to be taken.

Sir Walter Layton's pamphlet makes it abundantly plain that the critical importance of an adequate supply of newsprint is not adequately appreciated by the Government, and scientific workers on their side have the painful experience of the war years to impress on them the failure of either the Ministry of Supply or the Board of Trade to realize that books and periodicals are tools of research as essential as apparatus and laboratories. To a Government department a first-class scientific monograph or work of reference is equated with the latest novel or a bag of chalk, and most technical or scientific librarians could testify to their inability to secure any acceleration of the import of the text-books which research workers were urgently demanding. It is understandable that the output of British scientific and technical books should in war-time have dwindled to negligible proportions, and it was inevitable that the supply of such books from European sources should be interrupted. That no Government department should have appreciated that this situation accentuated the need to import American books is another question, and such departmental short-sightedness was at times a direct handicap to research and to our war effort.

What is discouraging is to find so slight an improvement in the position eighteen months after the termination of hostilities in Europe. The output of British scientific and technical books is still slight, due in large part to the shortage of man-power. Dollar stringencies are still allowed to curtail our imports of American books. American publishers are to be congratulated on the energy with which they have faced the situation and for their enterprise in the reproduction of important German scientific and technical books; nevertheless, we are entitled to ask whether it is likely to be in the interest of Britain or of its scientific workers to leave such developments exclusively in other hands.

The shortage is particularly acute as regards publications of the text-book class. Correspondence in the columns of *The Times* on the shortage of books and the difficulties which university students experience in consequence is corroborated in the annual reports of important public libraries, one of which states that twenty students may be waiting at the same time to use the sole copy of a particular book which the students themselves are unable to buy or to borrow elsewhere. Moreover, the abnormal demands at present made on the universities, and the shortage of teachers increase the importance of text-books in university education. Without books, as Sir Charles Grant Robertson observed in this connexion, a real university education is impossible; nor in such conditions is it possible to explore in the newer universities the possibilities of the tutorial system as opposed to the lecture system on lines, for example, such as Dr. C. H. Waddington has suggested.

The repercussions of this shortage of books are in fact not felt solely in the universities, or in research, in industry, or in Great Britain alone. They affect the Colonial Service courses and also, as Sir Stanley Unwin has pointed out, there is an acute and unsatisfied demand for British books on the Continent of Europe and elsewhere. One function of the British Council is to make known British culture and achievements; but the actual production of scientific and technical text-books certainly does not come within its competence. It is doubtful whether much success can be expected to attend the establishment of an emergency pool of text-books, for example, by the University and Research Section of the Library Association; such copies as exist are unlikely to be idle and available for pooling. Moreover, such measures are at best palliatives and should not be allowed to deflect attention from the main objective —the increase of production.

As Mr. H. M. Cashmore, president of the Library Association, urges in his letter to *The Times*, the production of books, including the reprinting of standard texts, is a matter of vital importance. Scientific men may well be expected to take whatever steps are in their power to facilitate and coordinate supplies of materials, and to renew their representations to the Government on the importance of books not only in the training of students, in the formation of opinion and the promotion of international understanding and the exchange of knowledge, but also as essential tools in research and production. Nor should they forget that in the present situation it behoves them to see that the most effective use is made of available supplies of material for book production. There is no room for books or for periodicals which will not bear searching objective scrutiny, and the present shortage of labour makes it the more imperative that scientific workers should not only set their own house in order by the elimination of redundant books and periodicals; but also, by the rigorousness of their criticism and the impartiality and objectiveness with which they review scientific and technical publications, they can ensure that the highest possible standards of production and content are attained. This much being done, however, the central problem is the manpower situation. Until the various industries concerned in the production of books can employ the requisite number of workers and also make full use of their material equipment, the supply of all types of books is bound to continue seriously to lag behind the demand.

DEVELOPMENTS IN RUBBER SCIENCE

Advances in Colloid Science

Initiated by the late Elmer O. Kraemer. Vol. 2: Scientific Progress in the Field of Rubber and Synthetic Elastomers. Edited by H. Mark and G. S. Whitby. Pp. xl + 453. (New York: Interscience Publishers, Inc., 1946.) 7 dollars.

THE appearance of a comparatively comprehensive book on rubber science is an event of some importance. The last publication of the kind was Davis and Blake's "Chemistry and Technology of Rubber" (1937), and a comparison of this with the volume under review makes one immediately aware not only of the considerable advances which have taken place in almost every aspect of the subject, but even more strikingly of the shift of emphasis away from organic chemistry and towards physics and physical chemistry. This is not due to any reduction in the significance or importance of the organic chemical aspect, but rather to an efflorescence of new concepts and ideas of a somewhat revolutionary character in the physical realm which have combined to make rubber science one of the most fascinating of present-day studies.

In the second volume in the series appearing under the title "Advances in Colloid Science" the editors have succeeded in choosing recognized authorities to write on their particular branches in such a way that the whole subject is fully covered, without introducing any undesirable repetition. Of the nine principal chapters, five deal mainly with physics, two with physical chemistry, and two with organic chemistry. In addition there are an excellent short introductory chapter by G. S. Whitby on the structure of synthetic elastomers, and an appreciative review of the work of the late Elmer O. Kraemer, by whom this series of volumes was initiated.

The rubber-like state, characterized by long-range elasticity, is associated with an amorphous or disordered arrangement of long-chain molecules in a state of micro-Brownian motion. If the regularity of structure along the molecular chain is sufficient, the amorphous state may, under suitable conditions, transform to a partially crystalline state, while at low temperatures both crystalline and amorphous states give place to the glass-hard condition. The transition to the glassy state—the so-called second-order transition—is discussed by R. F. Boyer and R. S. Spencer, of the Dow Chemical Company, while the phenomena of crystallization are treated by L. A. Wood of the U.S. Bureau of Standards. Another

imperfectly understood in terms of detailed reaction mechanisms. From Stevens's review of the subject there is seen to be much conflicting evidence on the effects of illumination, and further work designed with the object of providing more reliable experimental data is clearly called for.

Taken as a whole, this volume provides a much-needed co-ordination of recent developments, and will be eagerly studied by all whose work is associated with rubber and polymers, and, it is to be hoped, by others as well. L. R. G. TRELOAR

ELECTRIC FILTERS AND CRYSTAL LATTICES

Wave Propagation in Periodic Structures

Electric Filters and Crystal Lattices. By Prof. Léon Brillouin. (International Series in Pure and Applied Physics.) Pp. xii+247. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 20*s*.

THIS book deals not with a special branch of physical science but with a general method and its applications to different problems. Its striking feature is the number and variety of subjects which are accessible to the same mathematical treatment: on one side problems of pure physics, like scattering of X-rays by crystals, thermal vibrations in crystal lattices, electronic motion in metals, and on the other side problems of electric engineering, namely, propagation of electro-magnetic waves along periodic circuits and filtering properties of such systems.

In a very attractive introduction the history of the problem is described. The work on periodical structures is as old as modern mechanics itself, since Newton's derivation of the velocity of sound in his "Principia" is based on the consideration of a linear lattice. Many distinguished mathematicians of the eighteenth and nineteenth centuries have written about this subject: the Bernoullis, Taylor, Euler, Lagrange, Cauchy, Baden-Powell and others. Lord Kelvin gave a detailed discussion of the wave propagation in a one-dimensional lattice and discovered all its main properties: the non-linear relation between wave-number and frequency, the existence of a maximum frequency of propagation for systems of equal particles and of several frequency branches for systems of different particles; in modern terminology, he found the 'filtering' properties of a periodic structure. These results were re-discovered when Einstein's theory of the specific heat of solids demanded a detailed study of crystal lattices.

The succeeding chapters of the book are devoted to a careful presentation of the facts indicated in the introduction. First a mechanical model of particles coupled by elastic springs is used, but soon (Chapter 3) electric structures are considered. Already here, in the linear case, the idea of the reciprocal lattice is introduced. A whole chapter (5) is devoted to the discussion of the velocity and the flow of energy, and the results are expressed in the language of electro-technics by regarding the vibrating system as a transmitter of signals, or as a filter for waves. This way of thinking, familiar to the electrical engineer, is somewhat strange to the physicist. I confess that I have never looked on a lattice as a frequency filter. But this aspect is most interesting, and it is not difficult and most useful to express the results in terms of "passing bands" and "stopping bands", impedance and other such technical expressions.

The propagation of waves in two- and three-dimensional lattices is discussed with the help of the reciprocal lattice and of the 'Brillouin zones'. This conception was the main contribution of the author to lattice theory; he has published it in several papers and in a book, "Quantenstatistik" (Springer), and it has been used with great advantage in many investigations. The boundaries of the zones in reciprocal space are the locus of possible discontinuities of the energy distribution. Special cases of this general theorem are Bragg reflexions of X-rays, the energy distribution of electrons in metals and so on. The author applies it also to the theory of specific heat and other thermal properties of solids This is the only point in the book with which I cannot fully agree. Brillouin derives the distribution law of frequencies of lattice vibrations and shows that each branch contains as many frequencies as the number of cells of the lattice, and he continues (p. 161): "This is a very important and general result of the zone theory". In fact, it follows simply from the existence of the branches and has nothing to do with the zones. This is evident from the fact that it was found many years before the zones were discovered. The generalization of Debye's theory of specific heat based on this theorem (where a separate characteristic temperature is attributed to each branch) dates also from the pre-zone period.

While all the considerations so far are based on approximations (perturbation theory), Chapter 8 is devoted to a study of rigorous solutions in simple cases (Mathieu's and Hill's equation). The last two chapters are the most interesting ones as they give a full account of the author's own work on the propagation of waves along an electric line. Here matrix calculus is applied, and most interesting relations to Pauli's and Dirac's matrices, used in the theory of the spinning electron, are revealed.

The book is delightfully written. The author does not shrink from repeating a formula which has been derived before, so as to save the reader turning over pages. He never says "It is easy to prove" as many writers do (meaning, you have to work hard and spend a considerable time); but he gives the proof clear and simple. It is a work not only for instruction but also for enjoyment. MAX BORN

MAMMALS OF NEVADA

Mammals of Nevada

By E. Raymond Hall. Pp. xi+710+11 plates. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1946.) 42*s*. net.

THIS is a work by an enthusiast who lives for his subject and makes his subject live. Such is the thoroughness of the groundwork on which it is based and the completeness of the treatment that it is unlikely to be superseded. Dr. Hall's knowledge is based on the examination of some eighteen thousand specimens, most of which were collected by expeditions led by him between 1930 and 1936, during which he covered the whole State of Nevada.

The first part of the book is devoted to an explanation of his methods and to a discussion of general considerations of taxonomic and allied questions:

the factors responsible for geographic distribution (ecological factors), fluctuations, clines, speciation, etc. There is a most interesting section on the characteristics of desert animals and their mode of life, with particular reference to the conservation of moisture in the body.

The treatment of sub-species is sensible. The routine habit of regarding a geographically isolated form as a sub-species because it does not intergrade with any other forms has led to many absurdities such as the numerous 'species' of rodents from the isles of western Scotland. Dr. Hall found that pikas (*Ochotona*) occur in three widely separated mountain ranges in Nevada. Many rule-of-thumb systematists would treat them automatically as species. The author's criterion is this. If the variation between these isolated forms does not exceed the variation found between forms which have a continuous distribution, then he treats them as sub-species; and this is what he does with the Nevadan pikas.

Dr. Hall's way with common names is an example which should be universally followed. He gives the same common name to all sub-species of a given species instead of straining to invent so-called common names for each local race. He argues that the differences between sub-species are not usually apparent to the layman, and that for practical purposes when dealing with non-migratory kinds of mammals (in which no more than one sub-species occurs in one place) common names of species almost everywhere suffice if the locality concerned is stated.

The geographical data are excellent. There is a general discussion of the topography of Nevada and its climate. At the end of the book is a gazetteer giving the latitude and longitude of each place mentioned in the text and particulars of the maps used by the author. There is also a map on which are marked the Nevadan type localities, and in the body of the work are many distribution maps of individual forms.

The treatment of each form is very complete, and full field data are given. The author distinguishes between juvenile, young, sub-adult and adult, in that order of ascending age. Most authors seem to use 'juvenile' and 'young' indifferently. There is a glossary of technical terms which includes some clear diagrams explaining the conventional skull measurements of the different orders

The check-list is supplemented by a 'hypothetical' list of mammals which have not been recorded from Nevada but which the author thinks might occur there. There is a key to the mammals of Nevada which has good illustrations and no doubt works very well, but it is a pity that the layout of the key is so old-fashioned. The alternative halves of the main dichotomies are widely separated, which necessitates turning over several pages to find the second alternative and compare it with the first, and the minor dichotomies are indented progressively farther and farther, which is tiring to the eye. Much better is the type of key with the two alternatives of each dichotomy adjacent to each other and with no marginal indentations, thus:

(1) Four toes on hind foot (16)
    Three toes on hind foot (2)

(2) No tail (4)
    Tail (3)

(3) Black ears—*Mirabile dictu.*
    White ears—*Monstrum horrendum.*

etc., etc.

However, that is the only criticism I would make of this book.

Dr. Hall has not only written an excellent textbook on Nevadan mammals—he has written a book much of which will be of interest to all students of mammalogy. T. C. S. MORRISON-SCOTT

CORROSION OF METALS

Metallic Corrosion, Passivity and Protection
By Dr. Ulick R. Evans. Second Edition, with an Appendix by A. B. Winterbottom. Pp. xxxiv+863. (London: Edward Arnold and Co., 1946.) 50*s*. net.

THE first edition of Dr. Ulick R. Evans's "Metallic Corrosion, Passivity and Protection" appeared in 1937 and was reprinted in 1938, but has for some years been out of print. The second edition will be welcomed enthusiastically by all those interested in, and concerned with, the corrosion of metals. While the war years probably did not yield such a flow of new knowledge and information on corrosion as those just before the War, substantial advances have been made between 1938 and the present time. The author has striven effectively to avoid undue lengthening of the text in spite of his finding it desirable to refer to the work of some thousand additional contributors to knowledge on corrosion beyond those mentioned in the first edition. The new volume seems, in spite of some expansion of the text, to be of a very convenient and easily handled size. An important addition is an appendix on optical methods for the determination of films on metals by A. B. Winterbottom, who has made a special study of this subject.

The general arrangement and presentation are on the lines of the earlier edition, each chapter being divided into three sections which deal respectively with the scientific, technical and mathematical aspects of the part of the subject under discussion. Dr. Evans mentions that this arrangement seems to have made some appeal to the younger generation, but it cannot fail to have advantages also for research workers and technologists.

The text has been improved by some rearrangement, such as the collecting together of information on statistical approach into one section of the chapter on testing. The author has a unique knowledge and experience of corrosion studies and gives a masterly survey of the present position. Each in its proper place and in fitting sequence, the various contributions to knowledge of the subject are explained. The views of other workers are represented with admirable fairness, and the numerous contributions to fundamental knowledge of corrosion by the Cambridge school are mentioned with the author's usual modesty.

His own flair for recognizing the more obscure features of corrosion and for devising and using methods of gaining enlightenment on them, to which the Cambridge school of corrosion research owes so much of its success, has obviously assisted the author greatly in presenting this matchless store of information.

A remarkable feature of the work is the wide range of technical processes and products that are discussed in the light of modern knowledge and experience.

The book opens very appropriately with an introduction on the principles of electrochemistry in which the author deals with electrode potentials, polarization, over-potential and the effect of surface films.

Each of the fourteen chapters which follow is introduced by a section dealing with the fundamental aspects, which are linked up very usefully with technical matters and practical problems in the further sections. Technologists concerned with the fight against corrosion and all students of the subject will find this book invaluable. H. SUTTON

A NATURE DIARY

The Country Diary of a Cheshire Man

By A. W. Boyd. Pp. 320+15 plates. (London: Wm. Collins, Sons and Co., Ltd., 1946.) 12*s*. 6*d*. net.

A NATURE diary, even the baldest, is ever fascinating, not only to keep but also to read. It is undoubtedly the diary-like form of Gilbert White's letters that helps them to hold their place as the great classic of country and Nature writing. The present book inevitably draws upon itself comparison with that masterpiece, a comparison from which it emerges with all credit, for it is of the authentic Selborne school, detailing the daily happenings of the countryside with a gusto that communicates itself to the reader, touching on this item and that item with an enthusiasm and insight that brings illumination to the most everyday subject. Take, for example, the following remarks on the grey squirrel and the red squirrel: "One of the alien grey squirrels, now so securely established in England, was killed in Cheshire and given me a few days ago, and it is easy to see how the belief arose that it inter-breeds with our native red squirrel, although no authentic evidence whatever of hybridization between the two species has ever come to light. The one given to me was just changing its coat, and possibly that accentuated the redness of its fur in certain parts of the body; there was a russet streak along each flank and the same colour on the face, the hind legs, and to a less extent on the back."

We agree with the author regarding supposed hybrids between these two species, having so far failed to obtain any evidence of fraternization of these animals in a wild state.

Mr. Boyd's notes of his home county happenings are interspersed with short accounts of trips abroad in search of birds, such as a visit to Finland and another to Spain, and very interesting are his descriptions; yet not, in the reviewer's opinion, half so fascinating as his day-to-day reports of little homely things. He ranges over a wide field: birds may be his chief interest but he does not forget to mention that April 27, 1942, saw "green-veined white butterflies flying in the sunshine, and the beautiful pale lilac purple-streaked marsh violet has come into flower"; he adds, "although red campions were out eleven days ago, most of them still remain in bud".

Mr. Boyd makes an interesting observation with regard to birds on an experimental seed farm. "Gulls do harm in a remarkable way. They regurgitate some of the grain they have swallowed, and these pellets fall among the carefully numbered lines of wheat and oats and produce 'rogue' plants. The activities of the short-tailed field-mice have the same result, for they collect grain from several rows and heap it in the wrong place; one vole had carried 350 grains of rye and planted them thirty-five yards away."

It would be interesting to know if the culprits were identified for certain, as it sounds more like the work of that indefatigable little rodent the bank vole, *Evotomys glareolus*, than of the grass-eating, short-tailed, or meadow vole, *Microtus agrestis*.

A word of praise must be given to the excellent photographs—landscape, birds, insects and flowers—that illustrate this volume, the picture of that curious plant herb Paris and the study of white water lilies being particularly good. FRANCES PITT

GRAMME AND THE INVENTION OF THE DYNAMO

Zénobe Gramme

Notice bio-bibliographique suivie de la description de la dynamo par son inventeur et d'autres documents. Par Jean Pelseneer. (Collection Nationale No. 6.) Deuxième édition. Pp. 80. (Bruxelles: J. Lebègue et Cie., 1944.) 15 francs.

THIS booklet falls into three main parts—a bibliographical note on Zénobe Gramme by the author, the reprint of four papers by Gramme, his only published work, and a bibliographical list concerning Gramme and his invention, three items of which are reprinted in full, being difficult to obtain in the original.

Zénobe Gramme was born in 1826, into a large family of a Belgian minor Civil Servant. His education was most elementary, as he had not shown much aptitude for routine school work. He was skilful with his hands from early childhood and took carpentry as his profession. Through a Belgian acquaintance he obtained a job as a model-maker to a firm of instrument manufacturers in Paris, where he became interested in electricity. Soon he had inventive ideas and began to construct in his home an electro-magnetic machine capable of delivering uni-directional currents and thus suitable for replacing galvanic batteries, the only commercial source of electric power at the time. He was granted a patent for his invention in 1867, and founded a company for its exploitation in 1870. A description of his machine was first given in the *Comptes Rendus* in 1871.

Gramme's career from a carpenter's apprentice to a very successful company director differs from the more common fate of many self-taught inventors. He showed remarkable intuitive skill in concept, design and construction of his machine. A new source of power was gained by the rapidly developing industrial society, of which it was in great need.

The author devotes much space to the discussion of the priority dispute between Gramme and Pacinotti (1841–1912). Pacinotti, a professor of the University of Pisa, built an experimental model of an electro-magnetic machine in 1860 and described it in detail in 1863 in an Italian journal. Pacinotti's machine shows several remarkably modern design features and is close to Gramme's in its main idea. But he was a little too early with his invention, so that he did not succeed in finding sufficient financial backing. Gramme's machine was conceived quite independently and at once proved commercially successful. M. Pelseneer is inclined to give Gramme the olive branch for the invention, and uses arguments against Pacinotti which do not always carry conviction. It is interesting to note that Gramme did not take sides in the priority quarrel, which in the main raged after his death in France in 1901. Gramme's photograph is used as a frontispiece to the booklet, which is tidy if not very attractive in appearance.

Bibliography of Indonesian Peoples and Cultures

By Raymond Kennedy. (Yale Anthropological Studies, Vol. 4.) Pp. 212. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1945.) 16*s*. 6*d*. net.

THIS bibliography aims at giving a complete list of works relating to the islands of the Indian Archipelago from the point of view of anthropology and sociology, including archæology, linguistics, and studies of acculturation, but not omitting those works on geography, history, and economics which are pertinent to anthropological studies in general. The bibliography is set out on a geographical basis—general works first, then works dealing with particular areas, the list being divided in each case into works in Dutch and those in other languages. Eight main divisions are used—Indonesia in general, Sumatra, Java, Borneo, Celebes, the Lesser Sundas, the Moluccas, and Netherlands New Guinea. There are seven maps which show the location of the places and peoples appearing in the list. The mainland of the Malayan Peninsula and also the Philippine Islands are omitted from this volume, which is published in photolitho.

The list has taken some sixteen years to compile and must be very nearly complete; nevertheless, one or two omissions are to be found, and the very paucity of these is a testimony to the completeness of the whole.

Marsden's "Memoirs of a Malayan Family" (London, 1830) should have found a place under Sumatra, and Favre's "An Account of the Wild Tribes inhabiting the Malayan Peninsula, Sumatra and a Few Neighbouring Islands, etc." (Paris, 1865) might have justifiably been included in the general Indonesian list, though it is true that Favre deals primarily with the Golden Chersonese. Where there are several editions of a book there seems to be some inconsistency as to citation—thus, only an early (1783) edition of Marsden's "History of Sumatra" is given, but only the latest (1930) edition of Hamilton's "New Account of the East Indies". It is, however, obvious that in a work of this kind perfect completeness is almost impossible of achievement, and an occasional omission does little to impair the value of such a thorough and meticulous bibliography.

J. H. HUTTON

Organic Chemistry for Students of Agriculture (and Allied Subjects)

By Dr. Cyril Tyler. Pp. viii+341. (London: George Allen and Unwin, Ltd., 1946.) 15*s*. net.

AS the author points out in his preface to this book, there are many excellent text-books on organic chemistry. This particular book, however, has been written specially for the agricultural student. It has been designed to cover those parts of elementary theoretical organic chemistry which the student must master before passing on to a study of the carbohydrates, fats, proteins, etc., a sound knowledge of which is essential to an understanding of plant biochemistry, animal nutrition and dairy chemistry.

Dr. Tyler's simple and direct style will appeal to the student, and the excellent way in which he illustrates his text will prove a great help toward that appreciation of organic chemistry which can only come from a knowledge of structure. From the agricultural student's point of view his treatment of the carbohydrates, fats and proteins calls for especial praise, while the chapters towards the end of the book which concern vitamins, hormones, essential oils and other substances with which the agricultural student must have acquaintance are treated adequately.

The author's approach to his subject is essentially factual, and his book contains no mention of the history which lies behind our knowledge of the subject. It might be argued that the inclusion of matter of historical interest would have meant the excision of certain parts of the existing text if the book was to be sold at its present reasonable price. It is, however, difficult to make theoretical organic chemistry 'live' without some reference to its history. No doubt those whose students use this book will cover this aspect in their lectures.

R. G. B.

The B.D.H. Book of Organic Reagents for Analytical Use

Ninth and enlarged edition. Pp. x+196. (London: British Drug Houses, Ltd., 1946.) 4*s*. 6*d*. net.

THE appearance of a new edition of this well-known book will be welcome to all analytical and other chemists. Three reagents, dihydroxytartaric acid osazone for calcium, phenylthiohydantoic acid for cobalt, and phenylaminobenzene-azo-benzene sulphonic acid for magnesium, have been omitted as a result of experience obtained since the last edition. Four new reagents are included for the first time: triketohydrindene hydrate for the determination of free amino-acids, 8-hydroxyquinaldine for the estimation of zinc, benzyl*iso*thiourea hydrochloride for the characterization of sulphonic acids, and *p*-nitrobenzene-azo-orcinol for the determination of beryllium. In addition, the whole text has been thoroughly revised and the general level of excellence and accuracy of the previous editions well maintained.

F. B. KIPPING

Rapid Tomato Ripening

For Nurseryman and Amateur, with Notes on Possible Application to other Fruit. By L. D. Hills and E. H. Haywood. Pp. 143+12 plates. (London: Faber and Faber, Ltd., 1946.) 8*s*. 6*d*. net.

THE English climate is far from ideal for the production of outdoor tomatoes. The amount of ripe fruit harvested is almost always less than the total crop, even when this has been limited, as is the general practice, by pinching out the growing points of the plants.

Growers will therefore welcome this book, which describes in detail the use of ethylene or coal gas to ripen the green fruit after picking. This is the first practical manual on the subject, and as such deserves wide circulation among tomato growers. It describes the construction and operation of ripening boxes and chambers suitable for handling a few pounds or several tons of fruit. The book, which is based upon the authors' own experience, is written in a free-and-easy style, and though the frequent parentheses occasionally obscure the sense, the practical directions will be easily followed by the non-scientific reader. The authors are less fortunate in their attempts at scientific explanations; thus on p. 41 we read "The thermometer, by the expanding of the mercury molecules in which temperatures are measured . . .", and on p. 131 we are told that "The formula of ethylene is C_2H_5OH; that of acetone or amyl acetate . . . is C_3H_6O". The book is not, however, written for men of science, and these extraordinary statements do not detract from its undoubted value to the tomato grower. It is attractively produced and illustrated.

W. E. BERRY

CHEMISTRY OF 'TERYLENE'

By J. R. WHINFIELD

A RECENT announcement by the Calico Printers' Association, Ltd., and Imperial Chemical Industries, Ltd., relates to a new fibre-forming polymer derived from terephthalic acid and ethylene glycol, to which the name 'Terylene' has been provisionally assigned.

Polymeric ethylene phthalate was among the first of the condensation polymers to be described by W. H. Carothers in his well-known series of papers entitled "Studies on Polymerization and Ring Formation"[1]. He later reported the preparation of p-xylylene carbonate and, incidental to the problem of effecting ring-closure through the meta- and para-positions of the benzene nucleus, of a number of polyesters derived from the acids m- and p-$C_6H_4(OCH_2-COOH)_2$. With these exceptions, however, the published work of Carothers in this field is founded exclusively on the reactions of aliphatic bifunctional compounds, more especially of those in which the reactive terminal groups are separated by an unsubstituted polymethylene chain. What indeed lends so much distinction to this work is the range and depth of the conclusions drawn from the study of the reactions of such comparatively simple compounds. It is now well known that these investigations laid the foundations for the subsequent development of nylon, the first representative of a class of purely synthetic fibres.

A typical nylon is poly-hexamethylene adipamide, obtained by the inter-molecular condensation of hexamethylene diamine and adipic acid, the conditions of the reaction being so adjusted as to yield a polymer having a molecular weight in excess of 8,000. Its structure is represented as follows:

$$\ldots -NH-(CH_2)_6NH-OC(CH_2)_4CO- \\ NH(CH_2)_6NH-OC(CH_2)_4-CO- \ldots$$

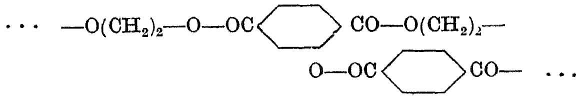
Poly-hexamethylene adipamide is a microcrystalline substance. In the massive state the crystals are randomly orientated, as may be shown by means of X-rays. It melts rather sharply around 270° C., and the molten polymer, which is very viscous, may readily be extruded into fibres. These fibres can then be extended to some four to five times their original length by the process of cold-drawing, and thereby acquire great strength and pliability. X-ray examination of the cold-drawn fibres shows that the crystals have become orientated in a direction parallel to the fibre axis.

Microcrystallinity and a capacity to yield strong and pliable fibres are properties by no means confined to the linear poly-amides; they are exhibited in varying degree by the analogous poly-esters and the poly-anhydrides of the component acids as well as by other types of polymers such as those of ethylene and vinylidene chloride. The particular importance and value of the poly-amides from the fibre point of view resides very largely in their high melting points, which are much in excess of those of the polymers enumerated above. Microcrystallinity and high molecular weight are apparently the essential attributes of fibre-forming polymers; high melting point and a certain degree of chemical stability are practical necessities.

The work resulting in the discovery of 'Terylene' had as its starting point the general problem of the relation between crystallinity and the molecular architecture of high polymers, and was pursued in a number of directions. It was commenced at a time (1939) when there was already available a good deal of information on this question, most of which pointed to the view that molecular symmetry was the dominant factor determining microcrystallinity[2]. From this point of view, therefore, isomerism in the benzene nucleus, resulting in both symmetrical and unsymmetrical distributions, presented some interesting possibilities.

The polymeric poly-methylene phthalates first described by Carothers were all devoid of crystallinity; the corresponding isophthalates and terephthalates were unknown. Of these the former should be amorphous and the latter crystalline

These expectations were experimentally confirmed Polymeric ethylene isophthalate proved to be an amorphous resin, while polymeric ethylene terephthalate was found to be highly crystalline. The structure of polymeric ethylene terephthalate is represented thus·



It is of incidental interest to note that Bucher and Slade[3] reported so long ago as 1909 the preparation of the anhydrides of both isophthalic and terephthalic acids. They state: "The properties of these anhydrides indicate that they have a high molecular weight and that they may be represented by the formula $[C_6H_4(CO)_2O]_x$".

A few minor difficulties were encountered in the preparation of polymeric ethylene terephthalate, but in most respects this follows the usual procedure appropriate to this class of reaction. It may conveniently be obtained by direct esterification of the glycol or by catalysed ester-interchange between the glycol and dimethyl terephthalate. The solubility of the poly-ester in organic liquids is very restricted, and in order to follow the progress of the reaction it was found necessary to determine the intrinsic viscosity in nitrobenzene at 150° C. This did not provide a reliable basis for the calculation of molecular weight.

Polymeric ethylene terephthalate—or 'Terylene'—as obtained by the solidification of the viscous reaction melt is a hard, porcelain-like substance, melting slightly above 250° C., and displaying random crystalline orientation. It is also obtainable in a condition of random crystalline orientation as a powder, by recrystallization from nitrobenzene and a few other solvents in which it is sparingly soluble at high temperatures.

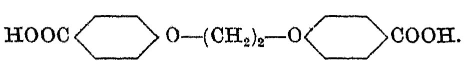
If, however, the molten polymer is cooled very rapidly by quenching with water, it solidifies to a colourless, transparent and completely amorphous glass. In this form it is physically unstable, and on gently warming reverts suddenly to the crystalline state in a rather striking manner. These two forms of the material are distinguished by some difference in chemical reactivity.

Fibres are obtained by extrusion from the melt and subsequent cold drawing, and are highly orientated (see *Nature*, Dec. 14, p. 871). A knowledge of their full range of properties must await the results of the more detailed evaluation now in progress. At an early stage of the work, however, it seemed evident that these properties were of a promising order from a textile point of view.

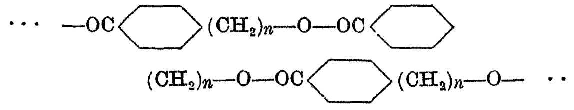
'Terylene' was first prepared in the expectation that it would prove to be a fibre-forming polymer, but the influence on the properties of the material as a whole of the symmetrically disposed, recurring benzene nuclei in the linear chain could not be predicted with any degree of certainty. All that could be inferred was that, in comparison with the purely aliphatic fibre-forming polymers, the chains would be less flexible, since there are fewer points of rotation in a given length. Nevertheless, they apparently retain sufficient suppleness to permit cold-drawing. That the poly-ester would have a high melting point appeared probable but by no means certain.

The possible effect of the ester linkages on the general chemical stability of the fibres was a very speculative matter. On one hand, unlike the amide linkages in the poly-amides (and in natural silk) the ester linkage should not induce instability to heat and light, and it has now been reported that 'Terylene' is notably resistant towards these agencies. On the other hand, the normal susceptibility of the ester linkage to hydrolysis at first gave rise to some misgivings. It was therefore rather surprising to find that 'Terylene' fibres remained apparently unaffected when subjected to quite severe hydrolytic treatments. This behaviour must be accounted for by the high degree of orientation and the close molecular packing—the density of 'Terylene' approximates to 1·4—whereby access of hydrolytic agents is rendered difficult, if not altogether prevented. In this connexion it is of interest to remark that undrawn 'Terylene' fibres are readily dyed by many dyestuffs commonly used for the dyeing of cellulose acetate rayon, but after cold-drawing the dye affinity of the fibres is very much reduced.

The higher polymeric polymethylene terephthalates show diminishing melting points with increasing length of the polymethylene chain separating the ester linkages; trimethylene terephthalate melted at 221° C. and the decamethylene ester at 123° C. These higher esters, however, all yielded orientated fibres when in a condition of sufficiently high molecular weight. On the other hand, esterification of diethylene glycol with terephthalic acid gave only amorphous, rubber-like poly-esters from which useful fibres could not be obtained. It is known that similar products result from the esterification of diethylene glycol and its homologues with the acids $HOOC(CH_2)_nCOOH$. The effect of the ether linkage is, however, variable. The higher polymers of ethylene oxide are crystalline, and Dr. J. T. Dickson, while engaged on the present studies, obtained microcrystalline fibre-forming polymers by esterifying the glycols $HO(CH_2)_nOH$ with the acid



From acids of the series p-HOOC—$C_6H_4(CH_2)_n$ OH, microcrystalline fibre-forming poly-esters were obtained by self-condensation. These are of the type:



The poly-ester derived from p-hydroxymethyl benzoic acid is in many respects not dissimilar from 'Terylene', but shows a greater tendency to persist in the amorphous condition—behaviour perhaps attributable to its rather lower degree of molecular symmetry.

The investigations which have now been briefly outlined were pursued by my colleagues (in particular, Dr. J. T. Dickson, Mr. W. K. Birtwistle and Dr. G. G Ritchie) and me in the laboratories of the Calico Printers' Association, Ltd., during the period 1939–41, and met with many difficulties on account of the War. The preparation of 'Terylene' on a somewhat larger scale ultimately became necessary, and this was undertaken at a later period by Dr. D. V. N. Hardy of the Chemical Research Laboratory (Department of Scientific and Industrial Research), at the request of the Ministry of Supply. A sample of 'Terylene' prepared by Dr. Hardy was eventually submitted to Imperial Chemical Industries, Ltd., for preliminary evaluation.

I would like to conclude this short account by an acknowledgment of my indebtedness first to the work of Carothers, of which the present investigations are a logical extension; secondly, to my early association with the late C. F. Cross, the discoverer of the viscose reaction, from whom I first acquired an interest in the chemistry and structure of fibres that has endured for many years.

[1] See Part 1 of the collected papers of W. H. Carothers in Vol. 1 of "High Polymers" (Interscience Publishers, Inc , New York, 1940).

[2] For a more detailed discussion of this question see Whinfield, *Chem. and Ind.*, **62**, 354 (1943)

[3] *J. Amer. Chem. Soc.*, **31**, 1919 (1909).

GEOPHYSICAL PROSPECTING AND ENGLISH OILFIELDS

At a Geophysical Discussion on English oilfields, held at the rooms of the Royal Astronomical Society on November 22, a large attendance demonstrated the interest aroused by the geophysical methods which have been widely applied in the intensive search for oil in Britain over the past ten years.

Dr. J. Phemister, in opening the discussion, gave a general account of the types of structure in which oil may be found, of the distribution of such structures in England, and of the geophysical methods employed in their detection. The types of structure possible in England include the stratigraphic trap, the closed anticline or dome, and the traps against an unconformity or a fault. In each case the porous stratum which is a potential oil reservoir must be sealed off by impermeable rock against both vertical and lateral dissipation of fluid, and the seal must have remained effective. In considering the distribution of structures which might act as oil-traps, the field of inquiry may be limited to those geological formations which provide some indication of the presence of oil. Such indications include seepages, gas-escapes, oil-impregnations, elaterite veins, and bituminous coatings in fractures and joints. The formations suggested by such signs as worthy of consideration are the Wealden and Corallian of the south of England, the Coal Measures, Millstone Grit and Carboniferous Limestone of the Midlands, and in Scotland the Calciferous Sandstone Series. From a well at Hardstoft in the Carboniferous Limestone, more than 3,600 tons of oil had been obtained in the years 1919–38. To these possibilities the Magnesian Limestone of northern Yorkshire has recently been added.

as a considerable gas-field in it has been proved by boring.

Closed anticlines in the Corallian and Wealden of southern England have now been extensively tested but no oil-field has been found. The main purpose of geophysical survey in this region would be to locate structural crests in Mesozoic strata below a cover of Tertiaries, and to determine the depths to the Palæozoic platform against which the Mesozoic strata overlap unconformably.

Structures in Carboniferous strata west of the Pennine Chain have so far proved non-productive, but east of this line four small oil-fields have since 1939 produced more than 300,000 tons of oil. They occur in closed anticlines in Millstone Grit which are concealed from surface observation by a thick unconformable cover of Jurassic, Triassic and Permian sediments. The structures were located principally by seismic survey, and this discovery represents a great achievement in the application of quantitative methods of refraction surveying on the part of the geophysical staff of the Anglo-Iranian Oil Co. In the search for similar oil-bearing structures, geophysical surveys have been extended over wide areas of Lincolnshire, Nottinghamshire and Norfolk. Many structures have been found, which although they have not been productive, are thought to indicate possibilities which should not be neglected.

In prospecting for concealed structures of the kind in question, two classes of geophysical survey—the gravitational and the seismic—are of particular value. Gravitational survey may be carried out by the Eötvös balance or by the gravity meter (gravimeter). The latter, being more rapid in operation and requiring less laborious corrections, is more suited to reconnaissance survey and has been extensively used in England by the oil companies. This instrument measures the amount by which g changes between a base station and other stations distributed over the area to be surveyed. Corrections for latitude, altitude and, when necessary, terrain are applied, and from the corrected observations a chart showing contours of equal difference in g (isogams) is prepared. The isogam chart shows the positions of local gravity maxima. These may be rendered less apparent but cannot be obliterated by regional changes.

Interpretation of gravitational surveys is based on the fact of experience that, close above the crest of a dome formed in a normal series of sediments, the force of gravity reaches a local maximum value. Similarly, above the position where an unconformable platform of old rocks comes nearest to the surface, gravity attains a maximum. Between these two structures, fundamentally different geologically, gravitational survey may not be able to discriminate, but it will supply the information necessary to decide the position for a boring which will prove the nature of the rocks in the concealed structure at least expense.

Seismic surveys also may be carried out by two methods. In the reflexion methods, depth to a bed which is accepted as an areal marker is deduced from the time elapsing between the firing of a shot at the surface and the arrival of the wave reflected from the bed. The method has not proved reliable in investigating the presence and depth of the Carboniferous Limestone in England. The refraction method, on the contrary, has proved capable of contouring the top of this formation with considerable precision, and its predictions have been checked by boring. Refraction survey may be carried out by the procedure of arc-shooting in which the seismographs are stationed on the arc of a circle of about two to three miles radius and centred on the shot-point. Anomalously short travel-time signifies the approach towards the surface, along the radius concerned, of a high-velocity medium. By shooting a number of arcs, the interesting area can be delimited. In straight-line shooting the seismographs are set out on a line through the shot-point, and the time-distance graphs constructed from the observations yield data for calculating the depth to the refracting interface and the average velocity of the waves in the overlying and underlying rocks. The velocity is to a considerable degree diagnostic of the rocks, as the following figures, provided by Mr. R. Davies, chief geophysicist, Anglo-Iranian Oil Co., show: Keuper Marl, 7,600–9,000 ft. per sec.; Coal Measures strata, 12,000–14,000 ft. per sec.; Carboniferous Limestone, 18,500–19,500 ft. per sec.

A gravitational survey at present in progress in the region between Bristol and London, and the results achieved up to date, were then described by Mr. L. H. Tarrant, of the geophysical staff of the Anglo-Iranian Oil Co., Ltd. The instrument in use is the Frost gravity meter, which consists of an air-damped box-beam carrying at one end a gold weight and at the other a drum to compensate air-buoyancy. A frictionless pivot is effected by a ligature device. The beam is suspended by a mainspring which is attached to the framework vertically above the axis of rotation of the beam and is in an almost astatized condition. By raising or lowering the point of attachment of the mainspring, the beam is set for the average value of gravity of the region which is to be surveyed. Observations are made by reading on a divided dial the rotation required to increase or decrease the tension on a reading spring required to return the beam to the null position corresponding to an arbitrary zero of gravity anomaly at a station accepted as the base station of the survey. The divisions of the dial are calibrated by reading at stations between which there is a known difference of gravity. An instrumental correction must be applied to the observations for drift of the zero; this is determined empirically by re-occupying an earlier station at two-hour intervals, and applied on the assumption of a linear change with time. Temperature correction is eliminated by thermostatic control of the instrument. The sensitivity of this gravity meter is rather better than 1/50 milligal (0·000,02 cm./sec.^{2}), and the probable error of an observation estimated from a number of observations at individual stations is 1/30 milligal.

The area which it is intended to survey covers about 5,000 square miles and overlaps in the south-west the locus of a gravity meter survey south of the Mendip Hills carried out earlier by the Gulf Exploration Co., Ltd. About 2,000 square miles have been covered and nearly four thousand stations occupied. A magnetic survey has been run concurrently but not with such detail, 850 observations having been made. The chart of isogams constructed from the observations corrected for difference in latitude, elevation and, in some cases, terrain, reveals a regular disposition of maximal and minimal areas of gravity anomaly. On the west, high values of gravity are conspicuous and are readily correlated with the Mendip anticline and the partly concealed outcrop of the Carboniferous Limestone along the eastern flank of the Bristol basin. The Mendip axis can be traced under cover of the Mesozoic strata as a long spur of diminishing gravity anomaly, and low maximal ridges indicate its continuation as a line of minor importance which curves east and then east-south-east beneath the north margin of Salisbury Plain.

The most remarkable and unexpected feature of the isogam chart is a deep trough of low-gravity values extending in a south-north direction approximately through Cirencester. From this axis gravity increases steadily and rapidly eastwards, and the chart shows a plateau of high gravity with two broad maximal areas between Oxford and Swindon and north-west of Oxford. Magnetic anomalies show a similar areal disposition of high and low values, but the maxima are considerably displaced from the gravity 'highs'. No geological interpretation of these significant gravity anomalies is being put forward at present by the Company's scientific workers, who hope to obtain complementary data by the application of seismic refraction methods of survey. It is, however, of interest and importance to recall that a boring at Burford reached Coal Measures at 1,200 ft. from surface. The difference found by the gravity meter between the values of g at Bristol and Oxford is 8·5 milligals, the difference by pendulum measurement being 10 milligals.

The rate of survey by gravity meter is high in a country so well provided as England with good roads and with bench-marks, spot-levels and contours. The instrument can then be transported rapidly from station to station in a motor-car, and little time need be spent in surveying station sites for exact position and elevation. The average area covered each day in the survey described by Mr. Tarrant was 10 square miles, and the average number of stations occupied was nineteen. In countries poorly provided with topographic maps progress is very much slower; and where the ground conditions are difficult, it is estimated that to keep the gravity meter fully employed the services of three topographic surveyors are required. The instrument itself is easily portable, being of small bulk, moderate weight (35 lb.) and possessing a reliable system of clamps.

Mr. Tarrant was followed by Mr. J. E. R. Wood, also of the Anglo-Iranian geophysical staff, who described, in illustration of seismic refraction survey, an investigation which has just been carried out in north-east Yorkshire. The object of the survey was to study the Magnesian Limestone, which was already known to occur at 2,400 ft. in a boring one mile south of Redcar. To obtain basic information, the seismic survey was begun by carrying out a line-shoot as near as possible to this boring and orientated parallel to the probable underground strike of the limestone. It was found that the limestone acted as a refracting medium transmitting waves with a velocity of 19,500 ft. per sec. and that the average velocity in the overlying strata was 11,800 ft. per sec. From inspection of the time-distance graph and the amplitudes of the pulses, which were becoming weak at 15,000 ft., it was decided that the main survey by arc-shooting would be most effectively carried out using a radius of 14,000 ft. A system of arcs was then laid out, and in order to avoid distortion of the arc-time profile the shot-points were located suitably to the inclination of the refracting medium, so far as this may be indicated by the contours of the base of the Rhætic series.

From the results of arc-shooting, time-contours of interval 1/100 sec. were constructed over the area from the sea to Upleatham Hills in the south and between Marske and Grangetown. The contours revealed a dome in the Magnesian Limestone below the southern outskirts of Redcar, and a bore has since been drilled. The difference in depth of the limestone in the two borings differed from that calculated from the seismic results by only 40 ft., a length representing 3/1000 sec. It is of interest to note that the system of arcs and lines shot over the area contained three closed polygons, around which the sum of the time differences was small and less than the limit of accuracy of measurement. This fact indicates that the pulses employed came from the same stratum throughout the survey, and that there are no significant changes of velocity in either the refracting medium or the overlying strata. In extending the survey southwards, difficulties in interpreting the results were encountered, and are ascribed to (*a*) distortion of arc-time profiles when shot across troughs and, possibly, faults in the limestone; (*b*) the possibility of change in the true velocity in the refracting stratum; and (*c*) the possibility that the pulses did not arrive from the same bed on reversal of the direction of shooting.

In opening the general discussion which followed the formal contributions, Prof. V. C. Illing stressed the distinction between finding structure and finding oil. Suitable structure is necessary, but of as great importance to the main issue is the geological history of the strata in which oil is sought; and in assessing the oil-bearing potentialities of a region, as great consideration must be devoted to this aspect of the problem as to the discovery of structure. While there can be no question that certain British rocks had contained oil, is it to be expected in the light of their past geological history of severe folding and rupture that they now retain sufficient to repay the expense of intensive search? Prof. Illing said he had some years ago expressed his dubiety, and he continued to be dubious of an affirmative answer to this question. Regarding the purely geophysical aspect of the search for oil, one marvelled at the precision of predictions based on the results of seismic refraction survey. He was puzzled, however, by the failure of the reflexion method to yield reliable evidence of the Carboniferous Limestone, and would be greatly interested to know what explanation might be adduced.

The production of considerably more than 300,000 tons of crude oil which has already been attained was mentioned by Prof. A. O. Rankine, who emphasized the importance of the part played by geophysical survey in this achievement. While the evidence from borings and mining for coal had indicated the possibility of a fold near Eakring, it was by geophysical survey by the seismic refraction method that the existence of a closed structure in the Carboniferous Limestone had definitely been proved. He left it to Mr. Wyrobek to discuss the failure of the reflexion method. Referring to the interesting nature of the gravitational anomalies between Bristol and Oxford, he hoped that it would be possible for the geophysicists of the Anglo-Iranian Oil Company to investigate by seismic refraction tests the buried structures which had been indicated by the gravity meter surveys. Mr. Wyrobek then put forward his view that reflexion of compressional waves is most efficiently effected when the high-velocity medium is comparatively thin and is, so to speak, suspended in low-velocity strata. He believed the lack of success in detecting the Carboniferous Limestone by seismic reflexion survey was due to the massive character of the limestone, which absorbed a high proportion of the energy. He pointed out also that it is covered by strata of Millstone Grit and Coal Measures age, which have fairly high velocity characteristics. In contrast to this purely physical explanation, the suggestion was made by Prof. W. G Fearnsides and supported by Prof. O. T. Jones that the existence of a transition zone of interbedded limestones and shales between the Millstone Grit strata and the massive limestone may be responsible for the confusing and baffling reflexions.

In reply to a question by Mr. Wyrobek whether the accuracy of prediction of depth of the Magnesian Limestone from refraction shooting had been tested in the Redcar area, Mr Wood said that the discrepancy between prediction and boring data was 50 ft. at 2,120 ft. depth.

Dr. E. C. Bullard, in closing the discussion, directed attention to the fundamental advances which are being achieved alike in the study of the concealed geological structure of England and of the correlated magnetic and gravitational anomalies, and in the development of precise instruments of physical research, as a consequence of the quest for oil. The honours in the contribution of data fundamental to the elucidation of structure in England were evenly divided between the American and British oil companies. He would himself be interested to know whether Kater's pendulum station at Arbury Hill had been occupied in the gravity meter survey in the Oxford district, and Mr. Tarrant stated in reply that while this station lay considerably beyond his survey, the desirability that the gravity meter survey should be linked with absolute measurements of gravity was being constantly borne in mind by his Company's geophysical staff.

SYNCARIDA IN RELATION TO THE INTERSTITIAL HABITAT

By Dr. A. G. NICHOLLS
Department of Biology, University of Western Australia

THE Syncarida occupy an important position among the Crustacea, and are of considerable interest to carcinologists by virtue of certain primitive features which they show. The more typical forms, *Anaspides* and *Paranaspides*, are familiar to all zoologists, but it is possible that the less well-known Bathynellidæ may have an even greater interest. On account of their small size, these have tended to be overlooked, but no one has devoted more attention to them than has Dr. P. A. Chappuis, of the Speleological Institute at Cluj, in Transylvania. His work, extended over many years, has been carried on through the difficult times of the War, and the accounts of it have recently reached us in a series of papers dealing with subterranean fauna in general. As much of the more interesting results have been published in some of the less readily accessible journals of central and south-eastern Europe, a review of these may be of interest to zoologists.

An account of the history of *Bathynella*, and the related genus *Parabathynella*, was given by Chappuis[1] in 1939, the main points of which may be briefly recapitulated. *Bathynella* was discovered by Vedjovsky in 1880, from a well in Prague. His description, published two years later, was based on two specimens one of which was later lost, the other being a poor preparation mounted in Canada balsam. Vedjovsky, at that time, did not attempt to classify this crustacean, regarding it as of uncertain position, but he believed that it was of common occurrence and had previously been overlooked owing to its small size (1·5 mm.). In 1899 Calman[2], on a re-examination of Vedjovsky's preparation, was able to place it in the Syncarida. It then receded into the background—if not into oblivion—since no one was able to find more specimens until Chappuis, in 1913, rediscovered it in an abandoned well near Basle. Shortly after his discovery the well was filled in and the new source thus lost, but not before Chappuis had collected a number of specimens, three of which he sent to the British Museum (Natural History). These enabled Calman to give a thorough description of *Bathynella*[3]. Three years later, Chappuis again found *Bathynella* in the Swiss Jura Mountains, and sent specimens to Delachaux, who described these as a second species which he named after Dr. Chappuis.

Since then, owing to the intensification of interest in the fauna of underground waters, it has been found in many places in Europe, as shown on the chart given by Chappuis[1]. Its discovery in England by Lowndes[4] was by chance, but is none the less interesting on that account.

The related genus *Parabathynella* was first described by Chappuis[5] in 1926, his specimens having been obtained from a stream flowing from the Sveta Voda Cave in Jugoslavia. A second species was described by Sars[6] in 1929, from the Batu Cave, Kuala Lumpur, and Karaman[7] extended our knowledge of the European species by finding more mature specimens at Skoplje. These were regarded by Chappuis[1] as belonging to a distinct species, but there would not appear to be adequate grounds for this view.

It is a characteristic feature of the Bathynellidæ that, up to 1939, they had always been found in wells, in springs, or in streams in caves; that is to say, they are associated with water of subterranean origin. Because of the isolated nature of the localities where Bathynellidæ had been found, Chappuis[8] considered the possibility of their having been transported from one body of water to another over the surface. He concluded that this was most improbable, and it has been generally assumed that they inhabited the water of crevices (*Spaltengewässer*) which were in general intercommunication, a hypothesis which it is difficult to accept in view of their occurrence at points so far removed from the apparent centre of distribution as in the Pyrenees and in England.

Chappuis's more recent work, however, has shed new light on this problem, and has opened a new field of investigation. Largely as the result of the work of the late Dr. C. B. Wilson[9], it has been known for some time that the interstitial spaces of sandy beaches are inhabited by a varied and extensive fauna in which copepods are abundant. This fauna is not restricted to the marine environment, but is also to be found around the shores of lakes, and this environment has also received much attention of recent years[10]. Chappuis[11] has now extended these investigations to yet another type of habitat He has found that by digging holes in the sand and rubble within a few yards of swiftly flowing streams, and by collecting and filtering the water which accumulates in such pools, he has been able to collect a considerable and varied fauna.

In one such pool in the Körös Valley, from about 60 litres of water, he collected a new isopod, eight species of copepods, an ostracod, three species of mites, nematodes, oligochætes, *Hydra*, a quantity of insect larvæ, and *Bathynella*. In another place he found yet another new isopod (representing a new genus), an amphipod, and a varied assortment of other forms similar to the first.

He extended this work during the years which followed, and found places where he could collect *Bathynella* by the hundred, in all stages of development[12]. He later identified these as *B. chappuisi*, and gave additional notes on their biology[13]. Thus he has established *Bathynella* as an inhabitant of the permanent water of the water-table (*Grundwasser*), in suitable soil conditions, which indicates that its presence in wells, springs, and streams has been accidental. This fact, together with its small size, accounts for its having been overlooked and for the difficulty in finding it again subsequent to its first discovery.

Chappuis's discovery of the true habitat of *Bathynella*, and the abundant supply of material thus made available, has made possible for the first time a full account of its developmental stages. This work was undertaken by Bartok[14] who, though writing in Hungarian, has given a four-page summary of his work in German and a useful table showing the course of development of the body and its appendages through the seven stages. This account is well illustrated with clear text-figures. A point of considerable interest is that in the youngest stage, although the thoracic region is fully segmented, the abdomen consists of only three segments; one segment is added at each stage up to the fourth, in which the full number of six first appears. Of the appendages, the first and second antennæ show a progressive development from the first stage onwards, attaining their full development in the fifth stage. The second antenna in the youngest stage resembles the thoracic legs in structure.

Of the thoracic legs, only the first four pairs are present in the first stage, the fifth and sixth appearing in the second and third stages respectively. A peculiarity is shown in the order of appearance of the last two pairs: the eighth pair appears first, in the fifth stage, while the seventh pair does not appear until the sixth stage. Although the pleon is only three-segmented at first, the single pair of pleopods characteristic of *Bathynella* is present at that stage, though not fully developed.

In the caudal region the anterior pair of appendages first appears in the fourth stage, simultaneously with the appearance of the sixth abdominal segment, whereas the posterior appendages, interpreted as furcæ, are present throughout.

When *Bathynella* is referred to in a general text-book of zoology, it is usually dismissed as a degenerate Syncarid which has taken to an underground existence. However, while at first sight it might be expected that such a form, which has left the normal environment for a subterranean existence, should rightly be regarded as degenerate, *Bathynella* nevertheless shows certain very interesting features which can only be regarded as primitive. Its habitat, as Chappuis has shown, is analogous to that of the interstitial harpacticoid copepods. In conformity with their adoption of this peculiar habitat, both forms show a number of common features, such as the slender, elongate, very flexible body, and the loss of eyes. Although the interstitial copepods are thus specialized for this existence, they are far from being degenerate; and there would not appear to be any primary reason for assuming that the Bathynellidæ are degenerate because they share the same type of habitat.

The chief primitive characters shown by the Bathynellidæ are first, the retention of a free first thoracic somite; secondly, the presence on this somite of appendages (maxillipeds), which are practically undifferentiated from the other thoracic legs; and, thirdly, the possession of two pairs of appendages on the terminal segment of the abdomen. So far as the thoracic appendages are concerned, *Parabathynella* shows a greater number of segments in the exopods, thus indicating that it is more primitive than *Bathynella* in this respect.

The interpretation of the appendages of the caudal region has been the subject of divergent views and some controversy. In no other groups of Crustacea are there examples of the terminal abdominal segment bearing two pairs of appendages; even the other Syncarida show a tail-fan similar to that of the Decapoda. There is no doubt that the anterior pair are uropods, but the posterior pair, which are composed of single segments each armed with spines and setæ, are not so easily identified. Vedjovsky contented himself with calling them *Schwanzplatten*; Calman[2] interpreted them as probably furcal rami, though possibly the halves of a divided telson such as is found in many amphipods and some other Crustacea. Chappuis[8] gave preference to the theory of the divided telson, and Calman[3] concurred. But Sars[6] regarded them as a second pair of uropods, homologous with the third pair of the amphipods. It is possible that in drawing this homology he was misled by an inaccuracy in one of his figures to which Nicholls[15] later directed attention. The latter showed that they could not be homologous with the third pair in amphipods, and accepted the divided telson as an explanation. However, in 1939 Chappuis[1] reverted to Calman's original interpretation and gave new reasons for regarding them as furcal rami, explaining that the caudal segment was probably composed of the sixth abdominal segment with which the telson had become fused, and thus these appendages must be telsonic. Bartok[14] suggests that the presence of these appendages in the first young stage, while the abdomen is still not fully segmented, proves that Chappuis's latest interpretation is correct, since the telson could not be completely divided into two parts and still give rise to additional segments. However, this does not close the controversy, because there are reasons for believing that the two pairs of caudal appendages in the Bathynellidæ may represent those of the fused sixth and seventh abdominal somites, and may thus both be interpreted as uropods.

Chappuis[12], after discussing the habitat and distribution of certain forms which he obtained from the interstitial spaces of sand and rubble in the valleys of Transylvanian rivers, concluded that they are of marine origin, relics from the tertiary period when a great part of central Europe was covered by the Sarmatian Sea. It is a fact that some of the copepods, isopods, and amphipods found in that habitat have marine forms as their nearest relatives. He suggested that as this sea became increasingly fresh and later diminished in extent, many of its inhabitants remained behind in the sand and rubble masses of the emptying valleys, and are known to-day in the extensive variety of forms which inhabit such an environment. He concludes:

"Eines der altesten Elemente der Subterranfauna ist wohl *Bathynella*. Wir konnen zwar nicht sagen, seit wann das Tier unterirdisch leben muss, das einzige was wir überhaupt wissen ist, dass ihre nachsten lebenden Verwandten in Ost-Indien, Australien und Tasmanien zu finden sind und dass die fossilen Verwandetn im Perm und Carbon lebten. Seit dem Palaeozoikum sind weder in Marinen- noch in Süsswasser-Ablagerungen Überreste von Syncariden gefunden worden. *Bathynella* ist daher eines der altesten Elemente unserer Süsswasserfauna, denn schon ihre fossilen Vorfahren lebten in solchem. Das eigenartige ist, dass sich die verschiedenen Bevolkerungen nicht artlich differenziert haben. *Bathynella* aus Südengland ist von den Tieren aus Siebenburgen (Transylvania) kaum zu unterscheiden."

If Chappuis's theory be correct, here is good evidence for the antiquity of the Bathynellidæ, and the fact that they have retained certain primitive characters supports this opinion of their great age. At the same time, in association with their subterranean habits, they have doubtless undergone some specialization, which has led to their being regarded as degenerate.

The recent discovery by Chappuis of the true habitat of *Bathynella* may have important results when similar situations in other parts of the world are studied in the same way. It would not seem unduly optimistic to suggest that an extension of his methods to other localities will not only widen the present known distribution of the Bathynellidæ, but may also bring to light hitherto unsuspected forms. Among these may be expected new Syncarida, which may throw further light on crustacean affinities. The discovery by Pennak and Zinn[16] of a new crustacean belonging to a new order (*Derocheilocaris*, Mystacocarida) was the result of further investigation of the sand environment of marine habitat. The alluvium of mountain streams is as yet practically unexplored, and may be expected to provide valuable information. *Bathynella* itself, although possibly related to the ancient Sarmatian Sea, is clearly not restricted to the area covered by that sea. *Parabathynella*, although represented by one species within that region, is also known from Malaya. The other Syncarida are Australian, and this region may well yield new subterranean forms.

Koonunga and *Micraspides* would appear to be intermediate forms between the true surface dwellers (*Anaspides* and *Paranaspides*) and the subterranean Bathynellidæ. Sayce[17] found *Koonunga* in "reedy pools beside a tiny runnel" under conditions where the water dries up for varying periods, and although it possesses small eyes, it "shuns strong light". *Micraspides*, which is without eyes, was found in water "drained from sphagnum", in detritus on the floor of pools in the bed of a creek and from the water which filled holes dug near a lake, in ground inhabited by the burrowing "land-crab", *Engœus*[15]. The size of these forms (nearly 10 mm.) precludes the possibility of their being interstitial in habitat, but it is possible that *Micraspides* may inhabit the burrows of *Engœus*.

These two forms thus link the surface dwellers with the subterranean, not only on account of their morphology[15], but also by reason of their habitat. While it cannot be disputed that the Anaspididæ–Koonungidæ–Bathynellidæ form a series showing reduction in complexity of structure, the possession by the Bathynellidæ of primitive features not seen in the other forms suggests not so much that they are degenerate as that they are primitive forms which have undergone simplification in relation to their underground existence. They have not been subjected to the same modifying influences as have the higher forms, which show clear evolutionary trends leading towards the condition of the higher Malacostraca.

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RADAR DETECTION OF METEOR TRAILS

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In the course of ionospheric observations made during the International Polar Year 1932–33, a transient type of radio echo was observed from levels in the upper atmosphere about 100 km. above the ground. Such echoes were found to last only a second or two and were noted to be equally frequent both by day and by night. A solar origin in terms of ultra-violet radiation could thus be excluded, and it was pointed out that, possibly, the ionization trails of meteors were responsible, since Skellet had already noted major increases of abnormal *E* layer ionization to occur at night when meteors were observed to pass overhead.

Since 1932, many studies of these transient echoes have been made as part of the programme of the Radio Research Board of the Department of Scientific and Industrial Research, and evidence has gradually been accumulated supporting the view that their persistent occurrence throughout the day is due to the general incidence of sporadic meteors. Most valuable studies of echoes from scattering centres in the *E*-layer of the ionosphere have been made by Eckersley and his co-workers, though, in their latest study of the direction of arrival and polarization of these scatter echoes, it was concluded that the results did not conform with the hypothesis of meteoric origin. Quite recently, however, Hey and Stewart, working with 5-metre waves, have shown a definite correlation between ionization bursts and meteor showers, and, using the results of more than one observing station, have in certain cases been able to determine the approximate position of the meteor radiant.

Since January 1944, daily observations have been made at the Research Station, Slough, of the diurnal and seasonal variation of these transient echoes. On October 10, 1946, however, an exceptional oppor-

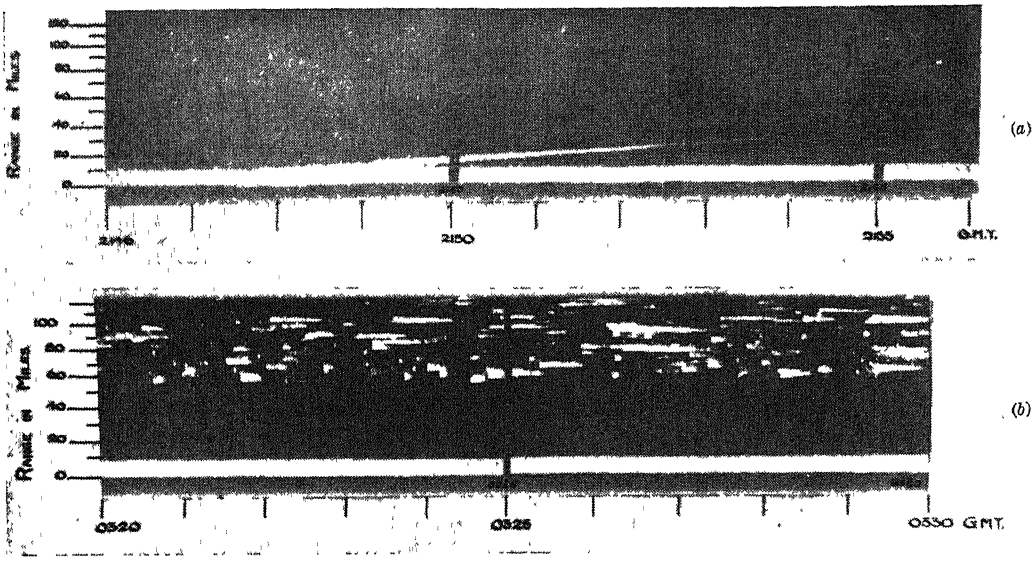

FIG 1. (a) TRANSIENT ECHOES RECORDED ON 27 MC./SEC ON OCTOBER 9 1946 (b) IONIZATION TRAILS RECORDED AT SLOUGH DURING THE GIACOBINID METEOR SHOWER ON OCTOBER 10, 1946

tunity occurred for testing the meteoric hypothesis of their origin during the Giacobinid shower. For that purpose a radar sender and receiver operating on a frequency of 27 Mc./s. was used. The aerial system, designed to radiate principally in an upward direction, had been erected for us by 60 Group of the Royal Air Force. Pulses of 15 microsec. duration and of a repetition rate of 50 per sec. were used, and the usual cathode-ray oscillograph display of ground- and echo-pulses was employed. For photographic recording the whole of the tube except the time base was masked off, and a strip of photographic paper moved slowly in a direction at right angles to the time base, so that the breaks in the time base, due to the ground pulse and the echoes, formed traces on the paper.

In Fig. 1a is shown a record of this type in which the range marks are also indicated automatically. The record, which was made before midnight on October 9, 1946, is of ten minutes duration. Three transient echoes were recorded as occurring at 2148, 2151 and 2155 G.M.T. (The continuous rising trace in the middle of the record is due to the echo from a single aircraft flying away from the observing station.) In Fig. 1b is shown, for comparison, the type of record obtained at the height of the meteor shower on October 10, 1946, which illustrates the very numerous echoes registered during a similar ten-minute interval. The duration and ranges of the transient reflecting meteor trails can be clearly measured. It is also interesting to note that the reflecting trails did not reach levels substantially below 90 km. above the ground.

A comparison of the rate of transient echo occurrence during the shower and at other times is shown in Fig. 2. For example, on the night of October 2/3, 1946, which is taken as illustrating normal conditions, the rate of occurrence is low, though it is noted that the rate is higher after midnight than before. This is in keeping with the hypothesis that sporadic meteors are responsible for the transient echoes, for in the morning hours the point of observation on the earth is running into such meteors and in the evening it is running away from them. On the same figure is shown the result for the Giacobinid meteor shower which occurred between 0000 and 0600 G.M.T. on October 10, 1946, with a maximum of activity between 0300 and 0400 G.M.T. No visual observations on this particular shower, which occurred when the weather was cloudy over almost the whole of Great Britain, are yet available to us for comparison. It is, however, of interest that the shape of the curve in Fig. 2, which was obtained by radio methods, bears a striking resemblance to that shown in Fig. 3 which

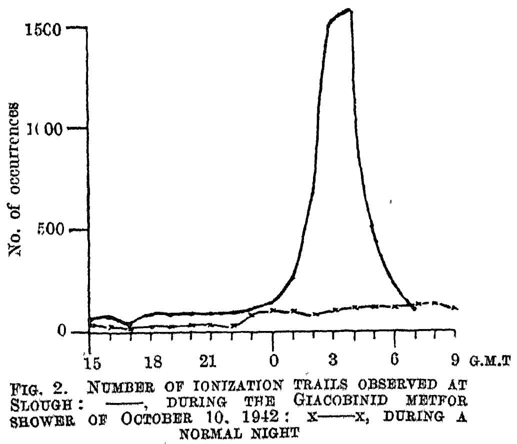

FIG. 2. NUMBER OF IONIZATION TRAILS OBSERVED AT SLOUGH: ——, DURING THE GIACOBINID METEOR SHOWER OF OCTOBER 10, 1942: x——x, DURING A NORMAL NIGHT

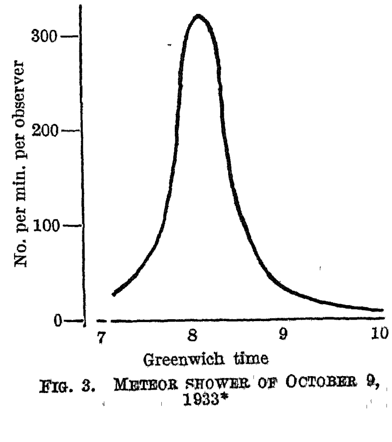

FIG. 3. METEOR SHOWER OF OCTOBER 9, 1933*

is due to F. G. Watson*, and shows the results of visual measurements made in the United States on the last occasion when an intense meteor shower, associated with the same comet, was observed.

This complete confirmation of the theory of the meteoric origin of short-period ionospheric echoes is most satisfactory, for we can now count our radio methods of ionospheric sounding as providing a reliable technique of meteor exploration which is applicable in all weathers and also during daylight. Moreover, since it is found that the effective reflecting power of meteor trails is increased as the exploring radio-frequency is reduced, we have been able to show that, using pulses of lower radio-frequency, many meteor trails may be detected and examined which escape even telescopic visual recognition

* "Between the Planets", by F. G. Watson, p. 129 (Blakiston Company, Philadelphia).

NEWS and VIEWS

Physics at the Royal Holloway College, London Prof. S. Tolansky

Dr. S. Tolansky, who has been appointed to the chair of physics at the Royal Holloway College, University of London, was born in 1907. He went to Armstrong College, Newcastle, where he started research in spectroscopy under Prof. W. E. Curtis After a period in London with Prof. A. Fowler and another in Berlin with Prof. F. Paschen, he joined the Physics Department of the University of Manchester in 1934. Dr. Tolansky has become a leading expert on hyperfine structure of spectral lines. He has made a number of important contributions and has elucidated the nuclear spins for a number of elements: As, Sb, Sn, Pt and Br I. He has also studied the nuclear magnetic isotope and quadripole effects for various atoms. Recently, Dr. Tolansky has developed new and powerful methods of interferometry, applying them particularly to the detailed investigation of surfaces of crystals, films, etc. These methods, which combine the properties of multiple-beam interferometry with those of wedge fringes, have proved a valuable means of investigating the structure of surfaces in a way that was not possible before. With it he has found it possible to measure differences of level of a few atomic diameters.

Institute of Experimental Psychology, Oxford Dr. William Brown

Those interested in psychology will be sorry to hear of the retirement under the age limit of Dr. William Brown from the Wilde readership in mental philosophy at Oxford. Dr. Brown retired from the directorship of the Oxford University Institute of Experimental Psychology last year. It was through Dr. Brown that the laboratory of experimental psychology was re-established—it had been started by Prof. W. MacDougall but disrupted by the First World War. The Wilde readership was first held by Prof. G. F. Stout who, after five years, moved to St. Andrews; and then by Prof. MacDougall, who retained it for seventeen years until he accepted the chair of psychology at Harvard. William Brown was a worthy follower in 1921 of these great psychologists. He had had considerable experience in clinical nervous and mental diseases during the War as medical officer in charge of Craiglockhart War Hospital for neurasthenic officers and as neurologist to the Fourth Army in the British Expeditionary Force in France.

With such experience, it was natural that Dr. Brown's interests should be directed towards psychotherapy. The nature of his publications showed that this was so. In 1920 he published "Psychology and Psychotherapy", which was so popular that it passed through four editions. In 1924 he edited and contributed to "Psychology and the Sciences", and in 1926 he published "Mind and Personality", and "Science and Personality" in 1929. In 1938 he wrote "Mind, Medicine and Metaphysics" and "Psychological Methods of Healing". These books were meant to popularize psychological treatment rather than contribute fresh knowledge to the subject, but were very valuable because of Dr. Brown's clear thinking and wide knowledge. Brown is also interested in social psychology, and in 1939 published "War and Peace: Essays in Psychological Analysis". In 1940, jointly with Prof. Godfrey H. Thomson, he wrote "The Essentials of Mental Measurement". Oxford will miss Dr. Brown's genial personality; he is continuing in full-time work in medical psychology in London

Dr. William Stephenson

Dr. William Stephenson, who has succeeded Dr. William Brown as director of the Institute of Experimental Psychology at Oxford, was appointed assistant director on its foundation in 1936. He had previously held the position of tutor and supervisor of post-graduate students in psychology at University College, London, and had specialized in mental testing and in the correlations of mental aptitudes with one another, having before that worked under the late Prof. Charles Spearman, who regarded him as his most outstanding pupil. Dr. Stephenson's researches in statistical psychology proved, among other things, the existence of a verbal factor, distinct from general intelligence, which needed to be 'partialled out' before correlation coefficients between mental tests could give mathematical support to Spearman's theory of a central intellective factor, *g*. Indeed, his joint research with Dr. William Brown, entitled "A Test of the Theory of Two Factors" (*Brit. J. Psychol.*, **23**; 1933); and summarized in *Nature* (**130**, 588, 1932, and **133**, 724; 1934), was held by Spearman to be the most adequate and convincing vindication yet produced of the scientific claims of his theory of *g*. During the Second World War, Dr. Stephenson was in charge of the work of applying mental tests in the Army. When the scientific results of this work come to be published, it should be found to be of the greatest interest and importance.

Ettore Marchiafava (1847–1935)

For centuries the Roman "Campagna" was a hotbed of malaria, and the part played by this scourge is well recognized in the "Decline and Fall of the Roman Empire" It is not surprising to find, therefore, that Italian malariologists have enriched our knowledge of its etiology and prevention. Before 1880, medical men and patients attributed the 'shivering ague' to an enigmatic nocturnal 'miasm'. In that year Laveran described the malaria parasite His discovery was confirmed and amplified by Marchiafava and Celli of Rome, who observed amœboid movements of the plasmodium within the red blood corpuscles and recorded an instance of the experimental transmission of malaria in man. A translation of Marchiafava and Bignami's researches on "Summer-autumn malarial fevers" was published by the New Sydenham Society in 1894. Born in Rome on January 3, 1847, Ettore Marchiafava in 1883 became professor of morbid anatomy and in 1916 of clinical medicine, remaining actively interested in medical research until his death on October 22, 1935, at the age of eighty-eight. He was the grand old man of Italian medicine, a leader of international science, and founder of the first Italian anti-tuberculosis sanatorium at Rome. Marchiafava was elected an honorary fellow of the Royal Society of Medicine in the year of its centenary, and one of his last publications was a communication in 1933 to its Section of Neurology on degeneration of the brain in chronic alcoholism. Distinguished in appearance and most approachable, he was a fascinating lecturer who made the dead live again as he recounted their clinical story and correlated it with the post-mortem findings.

Australian Guided Projectiles Range

SUBJECT to a satisfactory agreement between the two Governments on the financial and other aspects of the undertaking, the Australian Government has accepted the British Government's proposal that a firing range and associated technical facilities should be set up in Australia for experiments with guided projectiles and other long-range weapons. Lieut.-General J. F. Evetts, formerly senior military adviser to the Ministry of Supply, has left for Australia to collaborate with the authorities there in the detailed planning and execution of the project. In view of the numerous representations received, the Australian Guided Projectiles Committee and the director of Native Affairs will report to the Australian Cabinet to ensure the safety and welfare of aborigines in the proposed range area.

The Hon. J. J. Dedman, Australian Minister for Defence, made a statement in the House of Representatives on November 22 on the project for a guided missiles range and technical establishment in Australia. He emphasized that the scheme is a joint venture of Great Britain and Australia. The firing point will be in the vicinity of Mount Eda in South Australia, between the Transcontinental and North–South Railways. The direction of the centre line of the range is such that, if prolonged, it would pass roughly midway between Broome and Port Headland in Western Australia; that is, in the middle of the Ninety Mile Beach. The first step is to build a short range of about 300 miles, designed to be capable of extension at a later date, and to reserve the necessary area. The Government has also approved of the reservation of the Salisbury Munitions Factory for use, to the extent required, for the developmental work to be undertaken in Australia. Research and development on guided missiles has been under way for some time in Great Britain, whereas, so far, Australia has done no work in this field. Hence for some considerable time, by far the greater portion of the scientific staff required for the trials or research and development associated with them must be drawn from Britain. The capital cost of the range head and the first 300 miles of the range is £3,000,000, and the eventual annual maintenance cost of the range project is £3,000,000. If the development work is expanded, considerable additional capital and maintenance expenditure will be involved.

Except for a few pastoral leases at the firing point and in South Australia, the Central Aboriginal Reserves and a few more pastoral leases adjacent to the Ninety Mile Beach in Western Australia, the area of the range and that which it is proposed to reserve for eventual extensions is largely uninhabited For some years the range will come short of the Central Australian Aboriginal Reserves. During this period, it is expected that accuracy of control will be largely perfected; hence the risk to the aborigines, when the range is extended, will be negligible, for the average density of population is probably about only one native in every 50–100 square miles. Until the control is perfected, none but non-explosive missiles will be fired, possibly at the rate of one a week. A very limited number of observation posts may have to be established along the line of fire in the aboriginal reserve; in this connexion the director of native affairs and other authorities concerned in aborigine welfare are to be consulted.

Fire Research in Great Britain

H.M GOVERNMENT, through the Department of Scientific and Industrial Research, has decided to establish a comprehensive Fire Research Organisation, jointly with the Fire Offices' Committee. A Fire Research Board has been appointed jointly by the Department of Scientific and Industrial Research and the Fire Offices' Committee. The members of the Board are: Lord Falmouth (chairman), head of Fire Research ("F") Division, formerly Ministry of Home Security, now D S.I.R., past member of the Advisory Council and Executive Committee of the National Physical Laboratory, and of the Fuel Research Board; Dr. S. F. Barclay, head of the Research Department of Mather and Platt, Ltd., manufacturers of fire-fighting equipment; Mr. J. W Berry, general manager, Royal Insurance Co., Ltd., member of the Fire Offices' Committee; Mr. E. L. Bird, editor of the *Journal of the Royal Institution of British Architects*, member of the Joint Committee of the Building Research Station and the Fire Offices' Committee on the Fire Grading of Buildings; Sir George Burt, chairman, John Mowlem and Co , Ltd., chairman of the Building Research Board and of the Interdepartmental Committee on House Construction; Dr. S. F. Dorey, chief engineer surveyor, Lloyd's Register of Shipping; Dr. P. Dunsheath, chief engineer and director, Henley's Telegraph Works Co., Ltd.; Mr. A. J. Makins, general manager, Commercial Union Assurance Co., Ltd., member of Fire Offices' Committee; Air Commodore G. Powell, managing director, British Aviation Services, Ltd.; Mr. A. S. Pratten, chief officer, London Salvage Corps; Sir William Stanier, scientific adviser, Ministry of Supply, and lately scientific adviser, Ministry of Production, and chief mechanical engineer, L.M.S. Railway; Prof. D. T. A. Townend, director of the British Coal Utilisation Research Association; Mr. W. H. Tuckey, director of the Fire Offices' Committee Fire Protection Association. The members of the Board serve in their personal capacity and not as representatives of any organisation to which they may happen to belong.

Organisation of Fire Research

THE Fire Research Organisation is a joint scheme in which an industry and the Government are partners, sharing the cost equally. It will be responsible for the conduct of research on all aspects of the prevention and extinction of fires, on the safety of life in fires and the mitigation of damage, except that on the fire resistance of buildings the Organisation will collaborate with the building research organisation of the Department of Scientific and Industrial Research, where much research on this subject has already been done. A Fire Research Station will be jointly established. The capital cost is likely to be of the order of £75,000–£100,000, and the ultimate annual running cost up to £50,000, both shared equally between the Department and the Fire Offices' Committee. As part of its contribution to the capital cost, the latter will transfer its Fire Testing Station at Elstree to the Government. The following are the broad subjects on which research will clearly have to be undertaken, although it will be for the Fire Research Board to make a selection and allot priority of work: (1) methods of preventing the occurrence of fires; (2) methods of extinguishing fires and equipment; (3) fire protection of buildings, that is, on the fire resistance of buildings, properties of building materials, and elements of structure, safety of life in fires, the prevention of the spread of fire within buildings and from building to building; (4) other fire hazards, for example, ships, aircraft, special industrial hazards.

Textile Machinery Production in Britain

THE crucial importance of the relations between the textile industry and the textile machinery industry was emphasized in the report of the Working Party for the Cotton Industry, which recorded the broad impression that there is a clear need for more effort in Great Britain in regard to the perfection of the design of the machinery and the development of new methods of processing. This report has now been followed by a broadsheet (No. 252), in which Political and Economic Planning sets forth the facts and findings of a preliminary survey of the textile industry. The War has given rise to a very large accumulated demand for textile machinery from all textile manufacturing countries, since they have been unable to obtain new machinery for six years. Normal obsolescence requirements have been accelerated by production at high pressure with a minimum of maintenance, and total demand for textile machinery is likely to remain at a high level for years. Moreover, Germany and Japan are for the moment almost completely out of the picture, and the United States, the only other country with a large potential capacity, is at present preoccupied with its domestic market and was never a large exporter of textile machinery. For the time being, the task of satisfying world demand will in the main fall upon the British industry, and in view of the need to encourage exports with favourable long-term prospects, P.E.P. suggests that textile machinery should be given a high priority, in respect both of the allocation of labour and raw materials and the proportion of output devoted to export.

The capacity of the industry must be increased well beyond its pre-war limits. In the spinning, weaving and finishing sections, this could be facilitated by making use of the engineering resources of other areas. In all sections of the industry shortage of labour is the limiting factor to increased capacity, and the productivity of the present labour force is low in comparison with other mechanical engineering industries. Among the most important measures of reorganisation and modernization recommended are mechanization of machine shops and foundries, which should increase productivity, and, by creating better conditions of work and pay, help to attract new recruits; an increase in the average size of producing unit, particularly at the foundry-level, and standardization of product. At present, too many different types of machinery are manufactured for work on identical fibres, with heavy demands on skilled labour and restricted possibilities of using automatic machine tools.

Insect Control in Australia

THE use of D.D.T. as an agricultural insecticide has been investigated by G. A. H. Helson and T. Greaves (*J. Coun. Sci. and Ind. Res.*, **18**, No. 4, Canberra, Australia, November 1945). They find that it is effective against a variety of lepidopterous pests and also certain aphids, including *Myzus persicæ* and *Macrosiphum gei*, which can act as vectors for virus diseases. D.D.T. was ineffective against the cabbage aphid *Brevicoryne brassicæ*, woolly aphis and red spider. On the debit side, bees were seriously affected by this insecticide when visiting the flowers of sprayed bean plants. The experiments were on varied scales, from laboratory tests to field trials, and several methods of application were used. D.D.T. dusts were also found by T. Greaves (ibid., **18**, No. 2, May 1945) to provide the best control for a number of cabbage pests in north Queensland. Lead arsenate and calcium arsenate were also effective, but it would seem necessary to apply all three substances only to the early stages of growth of the crop, as they are toxic to man and higher animals. R. F. Powning (ibid., **18**, No. 2, May 1945) has evolved a method for the analysis of D.D.T. and pyrethrins in kerosene-based sprays. The two insecticidal components are separated by passage through a column of alumina. D.D.T. passes through, and is then boiled with alcoholic caustic potash to liberate hydrochloric acid, which can be titrated with standard silver nitrate solution. Pyrethrins are liberated from the alumina and estimated by the usual methods. Wheat stored in bulk is sometimes attacked by *Rhizopertha dominica* and other insect pests. F. Wilson (ibid., **18**, No. 2, May 1945) has shown that such outbreaks can be largely controlled by applying finely ground magnesite or dolomite to the surface of the mound. Smaller infestations can be dealt with by fumigation with carbon disulphide or ethylene dichloride.

Indexing and Filing Unpublished Material

THE report of the meeting on February 15, 1946, of the Association of Special Libraries and Information Bureaux to discuss the "Indexing and Filing of Unpublished Material" (see *Nature*, **157**, 259; 1946) has now been published. It includes the papers by Miss L. G. Thomerson on "Filing and Indexing Systems of Patra", Mr. W. Ashworth on "Correspondence Filing Problems of the British Cast Iron Research Association", Mr. A. E. Dodd on "The Filing of Unpublished Material in the British Refractories Research Association", and by Miss D. Knight, "Unpublished Material in the Library of the National Institute for Research in Dairying", which have not already appeared in the *Journal of Docu-*

mentation. The discussion includes contributions from Dr. F. Steggerda, director of the Nederlandsch Instituut voor Documentatie en Registratuur, and J. C. Groeneveld, of the Royal Dutch Shell Laboratory, and indicates the wide variety of practice. Two points which might be noted in passing are: first, the importance of relating the filing system to the quantity of material it is called upon to handle; and secondly, that notably in regard to correspondence, the papers and discussion collected in this report indicate a number of factors in efficient registry service which should be impressed firmly on all those using correspondence files, whether they bear any responsibility or not for the filing system itself.

Delinquency among Young People in Colombia

In *Revista de la Universidad del Cauca* (No. 9, June 1946), Luis Carlos Pérez deals with factors responsible for crime among young people in Colombia. The author provides statistics based upon the results of certain investigations, in particular of the cases where there has been death of one or both parents, and these present some interesting features. When the mother survives, the number of delinquents increases, but when the father survives it decreases; the greatest number comes from cases where both parents are alive. Offences against property are by far the most numerous, and next to these, but very much less numerically, are offences against persons and cases of vagrancy. Cases of lapses after reformatory treatment are numerous; they suggest that it has no effect or that the teaching is practically the negation of correctional. Other matters are discussed, such as the larger number of male than of female criminals, the criminality of women in Colombia (in 1944, out of a total of 5,217 people condemned for offences, only a little more than 6 per cent were women), the problem of crime among the Indians, the Indian in relation to the law in Colombia, etc. In connexion with the last point, there is no general legislation; the protectors and judges of the Indians are usually the missionaries. They are authorized to exercise civil, penal and judicial jurisdiction over them, in accordance with a law passed in 1890. Difficulties arise in those cases where it is not very easy to differentiate between Indians who are civilized and those who are not. The methods for obviating this difficulty are by no means ideal, and alterations in the system are matters of great importance.

Fruit Production and Propagation

The war-time concentration on food production and the turning over of many fruit-tree nurseries to short-term crops has resulted in an acute shortage of young trees to meet the needs of the expanding industry and the private garden alike. In addition, much experienced labour has been lost to the industry in general, so there is real need to make known in a practical form the most up-to-date methods of propagation and the accumulated experience of orchard management. These objects are admirably achieved by two recent pamphlets issued by the Ministry of Agriculture and Fisheries ("Apples and Pears". Bull. 133. Pp. 119+18 plates. 2*s*. 6*d*. net; and "Fruit Tree Raising: Rootstocks and Propagation". Bull 135. Pp. 46+2 plates. 1*s*. 3*d*. net. London: H.M. Stationery Office). The arts of budding and grafting can only be fully acquired by observing the green-fingered dexterity of the experienced propagator, and proficiency and speed are only achieved after long practice (100 buds or 70 grafts an hour are said to be good averages); nevertheless, Bulletin No. 135 does as much as can be done by precept. It includes, *inter alia*, chapters on the classification and uses of rootstocks; propagation from seed, cuttings, stools and layers; tree shaping; control of pests and diseases, and a useful calendar of nursery operations.

Bulletin No. 133 is a well-illustrated text-book of commercial apple and pear production, and covers all aspects of the subject from planning and planting to storing and marketing. There is a particularly good chapter on top-working and frame-working, but that on pruning might have been improved by reference to the results of pruning and shaping trials at the research stations. In the chapter on soil management, on the other hand, the section on cover crops does not distinguish very clearly between established commercial practice and recent experimental results which have not been tested commercially. Both bulletins provide the orchardist with authoritative manuals at negligible cost.

Diseases of Cereals in Scotland

The high atmospheric humidity in Scotland favours the rapid development of eyespot (*Cercosporella herpotrichoides*) on wheat and barley, but the severity of the disease is offset by the relatively long rotations employed. A survey carried out in 1944 (Mary D. Glynne, *Ann. Appl. Biol.*, **33**, 1, 35; 1945) showed 75 per cent of the autumn-sown wheat crops to be affected, and some 9 per cent showed obvious loss. Nearly all spring-sown crops of barley were affected; but damage appeared to be less than on wheat. Sharp eyespot (*Corticium Solani*) was widespread and was particularly common in Aberdeenshire; loss is apparently slight, but deep lesions may cause some straggling. Take-all disease (*Ophiobolus graminis*) was seen on less than half the wheat crops, and in only one case was 10 per cent of the straws affected. Except in Dumfriesshire and Aberdeenshire, it was much less common than eyespot, a conclusion similar to that reached by R. W. G. Dennis (*Ann. Appl. Biol.*, **31**, 370; 1944).

Coryndon Memorial Museum, Nairobi

The annual report for 1945 of the Museums Trustees of Kenya announces the appointment of Dr. L. S. B. Leakey (upon his release from war duties) to the full-time curatorship of the Coryndon Memorial Museum. Dr. Leakey, well known for his work in East African prehistory, has already carried out a great deal of work for this Museum in his capacity first as honorary curator and then as part-time curator. The Curator's report for the same year reports the holding of a Conference of Curators of East African Museums under the chairmanship of Dr. Leakey, and it is hoped that in future this will be an annual event. It was decided that a Federation of East and Central African Museums should be formed and linked with the Museums Association of England and the Empire. The same report makes reference to the possible development of the Museum as Kenya's War Memorial. During the year, the Governor called for suggestions as to what form the Kenya War Memorial should take, and a special committee was appointed to consider schemes sent in. Out of the ninety-eight received, two were selected for a final choice Of these, one was a scheme for a "Technical College for All Races", and the other a 'Museums Service Extension Scheme", which was submitted by the curator and by the Executive Committee of the Natural History Society. It will be remembered that Dr. Leakey referred to these proposals in a broadcast on the needs of the East African peoples which he made during a recent visit to Great Britain. He made it clear that so far as the East African native is concerned, the scheme envisaging a technical college is overwhelmingly favoured.

South African Association for the Advancement of Science

THE *South African Journal of Science* of June 1946 (volume 42; from the Association, Johannesburg) contains the report of the Johannesburg meeting in 1945 of the South African Association for the Advancement of Science, including the presidential address of E. C. Chubb, director of the Durban Museum, on "Museums and the Advancement of Science", the sectional addresses and the papers read or presented to the sections. The president, after indicating the services which the British Museum had rendered to the advancement of science, gave an interesting review of the activities of the museums of South Africa. Dr. H. van Gent's presidential address to Section A dealt with the contribution of variable star research to the progress of astronomy, while Mr. H. Wilson's presidential address to Section B, "Methane: a Neglected National Asset", discussed the potentialities of methane and urged the serious co-ordinated exploration of the country's resources of natural gas containing methane. Prof. C. J. van der Horst's presidential address to Section D, "Revolution in Evolution", reviewing the influence of Hugo de Vries' conclusion regarding evolution by sudden mutations, discussed more particularly the nature and origin of the trophoblast or feeding layer surrounding the mammalian embryo, and Prof. C. P. Lestrade, addressing Section E, dealt with "Some Problems of Bantu Language Development". Prof. Lestrade was concerned mainly with whether all or any of the South African Bantu languages should survive, and if so, with the part they should play in the life of the Bantu-speaking peoples, and secondly, how we could best ensure that the languages deemed worthy of survival could play the part desired, and he referred in conclusion to the lessons to be learned from the language situation in the Philippines. Of equal practical interest is A. J. Limebeer's presidential address to Section F on "The Employment of the Partially Disabled considered as a Social Policy".

Congress on Colonial Agriculture

THE Institut National pour l'Étude Agronomique du Congo Belge (INEAC), 12 rue aux Laines, Brussels, is organising at Yangambi, in the Belgian Congo, an 'agricultural week' during February 27–March 5. There will be visits to the Yangambi laboratories and gardens and to the neighbouring experimental stations. Papers will be read concerning Colonial agricultural questions, including particularly agricultural methods of promoting soil conservation. A report will be published in due course. Papers (two typewritten copies) should be sent to the Institute at Brussels by January 15 or to Yangambi (Belgian Congo) by February 1.

University of Sheffield: Appointments

THE Council of the University of Sheffield has made the following appointments: Dr. Arthur G. Walker, special lecturer in differential geometry in the University of Liverpool, to the chair of mathematics, in succession to the late Prof. P. J. Daniell, Dr. T. S. Stevens to be senior lecturer in organic chemistry; Dr. Quentin H. Gibson to be lecturer in physiology, H. J. V. Tyrrell to be assistant lecturer in chemistry; Dr. W J. P. Neish to be cancer research assistant in the Department of Pathology.

University of Cambridge: Appointments

THE following appointments have been made in the University of Cambridge W. L. S. Fleming to be director of the Scott Polar Research Institute in succession to Prof. F. Debenham, who has resigned: Dr. L E R. Picken, Dr. R. J. Pumphrey and H. W. Lissmann to be assistant directors of research in zoology. Prof. Carl Stormer, of the University of Oslo, will deliver the Rouse Ball Lecture for 1946–47.

Announcements

PROF. W. V. MAYNEORD, professor of physics applied to medicine at the Royal Cancer Hospital, London, will deliver a series of six lectures at the British Institute of Radiology on "The Applications of Atomic Physics in Medicine" on Wednesdays beginning January 1 at 5 p.m

THE Rector and Fellows of Lincoln College, Oxford, propose to elect an official fellow in chemistry, the appointment to commence on October 1, 1947. Particulars may be obtained from the Rector, to whom application, including a personal record and the names of three referees (but no testimonials), should be made before February 8, 1947.

AN election to the Pinsent–Darwin Studentship in mental pathology will be made at Cambridge in March. It is of the annual value of not less than £225 and is tenable for three years. The student must engage in original research into any problem having a bearing on mental defects, but may carry on educational or other work concurrently. Applications should be sent before February 28 to the Secretary, Pinsent–Darwin Studentship, Psychological Laboratory, Cambridge Applicants should state their age and qualifications and the general nature of the research that they wish to undertake. No testimonials are required, but applicants should give the names of not more than three referees.

FOURTEEN member firms of the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., have formed an Electronics Section. The first chairman is Capt. A. G. D. West, director of Cinema-Television, Ltd. One of the main objects of the Electronics Section will be to further and improve the manufacture of British electronic instruments and apparatus, an industry which has experienced a rapid growth during the last few years.

MR. ROBERT D. POTTER, former science editor of the *New York Herald Tribune* and staff physics writer on Science Service, Washington, D.C., is resigning after six years as science editor of the *American Weekly* to found his own science writing organisation. His firm will be known as "The Wordshop" with headquarters at Scarborough-on-Hudson, N.Y., U.S.A. Mr. Potter was a founder-member and twice president of the National Association of Science Writers.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Millimetre Wave Propagation

INFORMATION has recently been disclosed about the absorption band in the oxygen molecule for electromagnetic radiation of wave-length in the region of 5 mm.[1]. This communication gives preliminary details of an experimental investigation on propagation over sea of waves in this wave-length region.

The tests were carried out at Weymouth, where a transmitter was set up on a site on the northern breakwater of Portland Harbour. In the course of the experiments two transmitter positions were used, one at a height of 15 ft., the other at 48 ft. above mean sea-level. The receiver was mounted at the masthead of one of H.M. ships, at a height of 63 ft. Two wave-lengths were used, one of 5·81 mm., which is in the oxygen absorption band; the other of 6·35 mm, which is just outside the absorption band.

The transmitter was a klystron oscillator operating at a wave-length of twice the required value. Its output was fed into a crystal distorter which gave a second-harmonic output power of some 10 μW. The aerial system was a 16-in. paraboloid fed by a wave guide, giving a gain of about 40 db., with vertical polarization. A superheterodyne receiver with crystal mixer and a similar aerial were used for reception. Because of the narrow beam-width consequent upon its high gain, the aerial on board ship was fitted on a radar mounting stabilized against ship movement. The received signal was recorded continuously on a recording milliammeter.

Over a period of a week, twenty-five runs were made, moving on a straight course to or from the transmitter, covering a range from less than a kilometre up to some 12 kilometres.

Figs. 1 and 2 are representative curves of signal strength plotted against distance, curves A and B taken for the high transmitter site at the two wave-lengths, and C and D corresponding curves for the low transmitter site. For unattenuated free-space propagation, the signal strength should vary inversely as the distance d, and reference curves proportional to $1/d$ have been included in each figure. Ignoring for the moment the oscillatory nature of the curves, it will be seen that for the 6·35 mm. wave-length curves, A and C, the mean level closely follows the $1/d$ curve; this indicates that absorption is small. For B and D, however, taken at 5·81 mm. wave-length, the mean curves fall progressively below the $1/d$ line, showing the existence of atmospheric absorption. The nature of the curves and some uncertainty in the range figures make it impossible to state a precise value for the attenuation constant; but a figure of about 1·5 db./km. is indicated. This is considerably higher than the value of about 0·5 db./km. given by Beringer[1], even allowing for additional water vapour attenuation in the present measurements, which for the prevailing relative humidity of about 90 per cent will not amount to more than about 0·1 db./km. Beringer's measurements were made in the laboratory on oxygen mixtures contained in a short length of wave guide.

The other striking feature of the curves is the interference pattern shown. It might have been considered improbable, except possibly for very calm seas, that any considerable amount of specular reflexion from the sea surface would occur at wave-lengths so small compared with normal sea wave-heights. However, the figures show a regular pattern of interference between the direct and reflected rays. This explanation is confirmed by the close correlation between the observed maxima of the curves and their positions as calculated theoretically and shown for curve A by the short vertical lines. The positions of the maxima are calculated simply from those values of the phase difference angle ψ between the direct and reflected rays which make $\psi = (2n + 1)\pi$. The effect of the difference in transmitter height is clearly shown in the difference in spacing of the maxima between curve A and curve C.

Curve C shows the greatest amplitude of interference recorded during the trials. To give some idea

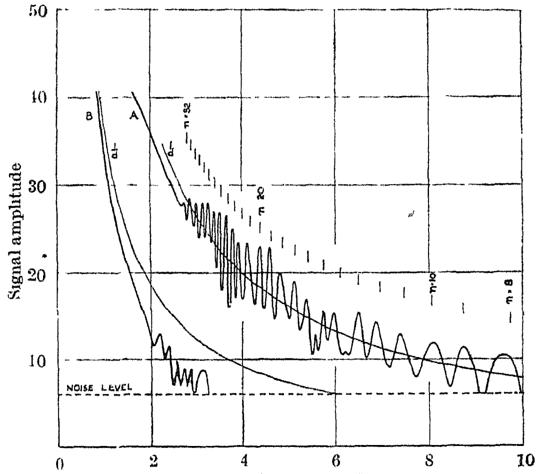

Fig. 1. SIGNAL STRENGTH/DISTANCE CURVES
A $\lambda = 6·35$ mm, B $\lambda = 5·81$ mm } High transmitter site

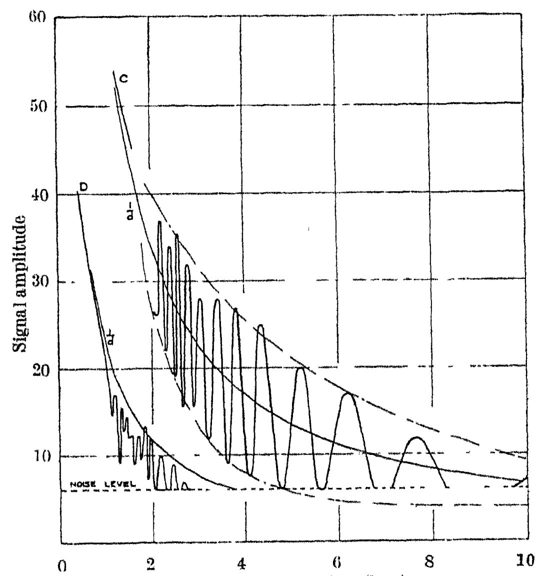

Fig. 2. SIGNAL STRENGTH/DISTANCE CURVES
C: $\lambda = 6·35$ mm, D: $\lambda = 5·81$ mm } Low transmitter site

of the magnitude of the reflexion coefficient, theoretical envelopes of maxima and minima have been added as chain-dashed lines to this curve; for the best fit, as shown, a value of reflexion coefficient of 0·8 is required. These envelopes have been corrected for the effect of the narrow aerial beam width, which cuts down the amplitude of the reflected ray at close ranges. Similar envelopes for curve *A* require a reflexion coefficient of 0·25. This estimated value was the smallest obtained during the trials, all others being intermediate between these limits.

The sea surface was in all cases fairly calm, with ripples not exceeding 12 in., low swell, and wind force 2. For curve *C* the sea surface was smoother, but not markedly so, than for curve *A*.

Certain laboratory measurements have been carried out on reflexion from water at the nearby wavelength of 8·7 mm. From these measurements, which it is hoped to report shortly, it is estimated that the reflexion coefficient of a plane sea surface for the range of grazing angles (less than 1°) occurring here would lie between 0·88 and 0·97. Thus for an actual sea surface the values obtained approach this upper limit.

The work is being continued with the view of getting accurate figures of attenuation and extending the frequency range.

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Nov. 15.

[1] Beringer, *Phys. Rev.*, 70, 53 (1946).

Solar and Sidereal 6-Hourly Variations of Cosmic Rays

THE study of the solar variations of cosmic rays has been continued in order to ascertain the possible existence of a third and fourth harmonic. The material for the analysis consists, as before[1], of bi-hourly numbers of triple coincidences for 860 complete days during the period May 1941–April 1944.

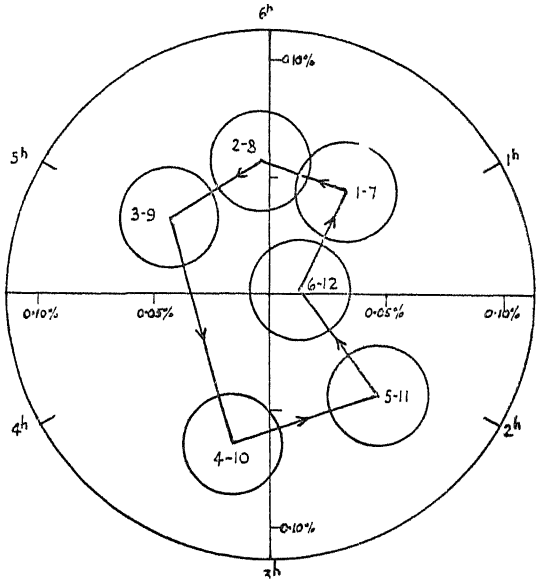
With regard to the harmonic of the 6-hour period, it is found that when all the data are taken together, no appreciable variation is apparent. But the result is entirely different if the data are arranged in 12 monthly groups and each one analysed separately. The following table gives the amplitude and phase for each group after correcting for non-cyclic variation and for pressure by using the barometric coefficient 0·345 per cent per mm. The first group refers to January for all three years, the second to February, and so on.

TABLE 1

Group	Ampl.	Phase	Group	Ampl.	Phase
1	0·117%	2°	7	0 098%	122°
2	0·034	37°	8	0 100	112°
3	0·032	190°	9	0 089	128°
4	0·102	270°	10	0·040	218°
5	0·087	321°	11	0 040	308°
6	0·028	42°	12	0·014	294°

Probable error : ± 0·030%

As shown by the table, the phase increases regularly in chronological order, suggesting that a sidereal effect is present. The existence of this effect is better



SOLAR TIME DIAL. THE RADIUS OF EACH CIRCLE REPRESENTS THE PROBABLE ERROR

shown, however, if the importance of the probable error is diminished by taking groups of pairs of months. In the harmonic dial of the accompanying figure, the mean amplitudes and phases for these bi-monthly groups have been plotted. January has been combined with July, February with August, and so on, in order to avoid increasing the smoothing effect. The orderly progression of the points in an anti-clockwise direction is beyond doubt.

But the possible existence of a superimposed solar variation cannot be excluded. To separate the two effects, if they actually exist, we can eliminate the sidereal one by taking the mean values of the groups of three or multiples of three successive months. Table 2 gives the mean amplitude and phase for cosmic rays of the 6-monthly groups November–April and May–October, together with, for comparison, the corresponding amplitude and phase for pressure.

TABLE 2

	Cosmic rays		Pressure	
	Ampl.	Phase	Ampl.	Phase
Nov.–April	(0 032 ± 0·012)%	318°	0 035 mm.	173°
May–Oct.	(0 034 ± 0 012)	115°	0·024	341°

As the table shows, the wave in cosmic rays is in the two cases opposite in phase to the pressure wave. The amplitude for cosmic rays is somewhat less than three times the probable error; but the fact that the means of any other pair of groups of six successive months appear to be always in a similar correspondence with those of the pressure wave seems to indicate that a real solar variation does exist, and that it is controlled by the barometric oscillation of the 6-hour period—a similar result to that obtained for the semi-diurnal variation[2].

As the variation of pressure for each monthly group is known from barograph readings, the ratio of the cosmic ray wave to the pressure wave, the value of which is roughly − 1 per cent per mm., enables us to obtain and eventually to remove the real solar variation. By doing so we obtain for the amplitude of the sidereal variation the value 0·057 per cent, which is six times greater than the probable error ± 0·009. The times of maxima are 4, 10, 16, 22 hr. sidereal time. The fourth maximum appears to occur at about the same time as that of the maximum of the 24-hourly sidereal variation previously obtained[1].

Ehmert[3], by a totally different method, has also deduced the existence of a 6-hourly sidereal variation, though its amplitude is not given.

It may be noteworthy that in the studies of radio-frequency energy from the stars, several maxima have been recorded which, according to Reber[4], may be associated with projections from the Milky Way analogous to the arms of other spiral nebulæ. If cosmic rays are generated, as previously suggested[1], in the stars, a similar cause might account for the sidereal fourth harmonic.

With regard to the third harmonic, no variation for cosmic rays appears which could be regarded as real.

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[1] Duperier, *Nature*, **158**, 196 (1946).
[2] Duperier, *Proc. Phys. Soc.*, **57**, 464 (1945)
[3] Ehmert, *Z. Phys.*, **1 1**, 260 (1930).
[4] Reber, *Astrophys. J.*, **100**, 279 (1944)

Solar Radiation at 480 Mc./sec.

FOR several months past, daily measurements of radio waves from the sun at 480 Mc./sec. have been made here at true noon. The normal observed intensity is about 5×10^{-19} watt/sq. cm. per Mc./sec., corresponding to an apparent solar temperature of about a million degrees. Superimposed on this are slow day-to-day variations of about 15 per cent which are quite closely correlated with the apparent area of sunspots. This variation is no doubt the same phenomenon on a greatly reduced scale which was observed by Pawsey[1]. The apparent solar diameter is about ½°, and no observable variation (less than 0·1°) has been found from day to day.

On November 23 a partial solar eclipse occurred here. On that day the observed solar intensity dropped about 25 per cent compared to the observed intensity on November 22 and 24. This is approximately the amount of the sun's disk obscured by the moon at noon. No change in solar width was observed.

On November 21 a great radio storm was observed similar in type to that described by Hey[2]. It started about 1630 G.M.T., increased in severity to about 1800 G.M.T. and then died down. A second smaller outbreak occurred about 1930 G.M.T. The storm manifested itself as greatly increased apparent radio intensity. The sounds coming from the amplifier were typical hissing or rushing noises quite similar to thermal agitation noise. However, instead of being steady as is the normal solar noise, this storm noise varied from second to second in amplitude. Thus the output meter showed an erratic reading, and the audible effect in headphones was much like wind whistling through the trees when no leaves are on the limbs. Occasionally great swishes occurred above the rapidly varying background. No snaps or crackling sounds could be heard which might be interpreted as lightning or sparking discharges of any kind.

At the peak of the disturbance the antenna was turned to declination 57° N., which is practically at right angles to the sun. All the solar background disappeared, but the occasional swishes could still be heard, quite weakly now. Since this storm was not expected, adequate arrangement had not been made to record its peak intensity. Observation of the output meters showed the background intensity to be more than four hundred times normal for a period of several minutes. The great swishes probably rose to several thousand times normal, judging from listening.

Exchange of telegrams with G. C. Southworth of the Bell Telephone Laboratories produced the information that solar intensity measurements had been made at a wave-length of 1¼ cm., but nothing unusual had been observed at this wave-length on November 21.

On the following night the apparatus was operated again to measure radiation from the galaxy. Since motor-car ignition noise is much less at night, the sensitivity was increased to about thirty times that used during the day. All night long there were quite faint noises similar to those heard at the preceding noon, but perhaps 10^5 times fainter. Due to faintness only individual swishes could be heard. These occurred at irregular intervals of from a second to a couple of minutes between swishes. Each individual swish lasted only about one quarter second. Often the swish was accompanied by faint grinding sounds with noise components near 300 cycles. The phenomenon weakened and died out toward dawn. The next day the sun appeared normal, and no more night-time swishes have since been encountered.

It seems likely the above night-time effect is directly associated with the previous noon-day effect, and that perhaps the whole phenomenon originated in the earth's atmosphere and not in the sun at all. The individual swishes might be due to noises set up in the upper atmosphere when some charged particle passed through it. Such a particle might easily originate in the sun.

The apparatus used here is automatically recording and usually operates unattended. Upon looking over my charts, I find that a similar phenomenon may have occurred on October 17 in a much attenuated form. No one was present when this chart was made. The background rose to only about twenty times normal on this day, and then only for a minute or so at a time. Several sharp spikes, most likely caused by swishes, are present on the trace.

Due to unsteadiness of the background, it was impossible to measure accurately the solar width on November 21. However, estimates show it to be not more than a few degrees and probably less at the half-intensity points.

GROTE REBER

212 W. Seminary Ave.,
Wheaton, Illinois.
Nov. 24.

[1] Pawsey, *Nature* **157**, 158 (1946).
[2] Hey, *Nature*, **157**, 47 (1946).

Demodulation by Superconductivity

WE have examined further the anomalous fluctuations in the superconducting bolometers previously reported by Andrews, Milton and Desorbo[1], and find that, in part, such fluctuations are due to the absorption by the superconductor of modulated broadcast radio waves and the conversion of the modulation wave, by the superconductor, to simple audio-frequency. Our experiments were carried out with superconducting bolometers using small ribbons of columbium nitride mounted in cryostats, and employing circuits as described in the preceding reference. Following the discovery on December 2, 1946, of demodulation of broadcast waves at 1,090 kilocycles, we generated waves in the laboratory at frequencies ranging from 200 to 30,000 kilocycles, and found that demodulation occurred only in four bands centred approximately at 1, 3, 5 and 16 megacycles. We have found this demodulation to occur only within a narrow temperature zone corresponding to a part of the transition interval between the normal and the superconducting state. The temperature for maximum demodulation was not affected by changing the radio-frequency. Quality of reception was comparable with good standard radio reception. Although no tuned radio-frequency circuit or antenna was used, the signal generated was estimated to be of the order of ten to one hundred microvolts at the terminals of the ribbon. Demodulation could be reduced or eliminated by passing small direct currents through the superconductor.

Superconductors may be useful for generating or receiving waves in frequency ranges where the use of present methods is difficult, or for improving present methods.

This research was carried out under a basic research contract with the Physics Division, Office of Naval Research, United States Navy, at the Chemistry Department, Johns Hopkins University, Baltimore, Maryland.

DONALD H. ANDREWS
CHESTER W. CLARK

Dec. 10 (by cable).

[1] *J. Opt Soc. Amer*, **36**, 518 (1946).

Determination of the Variation of Composition of Airborne Crystalline Materials with Particle Size

THE 'cascade impactor'[1] is a four-plate sampling instrument so designed that particles in successive size ranges are deposited in turn on the corresponding plate. While some overlapping of sizes occurs, the cut-off of the second, third and fourth plates is comparatively sharp (v. ref. 1), and this can be utilized in the following manner.

The microscope slides normally used in the instrument are covered on one side by a thin sheet of 'Cellophane' or aluminium foil, the foil being held in position on the slide by a small amount of cellulose acetate cement at either end The foil is then coated with a thin film of Canada balsam in xylene This must be done immediately prior to use, or alternatively the slides must be stored in xylene vapour. The slides are inserted in the usual way, and a sample much denser than for normal counting is taken. It is necessary to avoid continuing the sample to a point where the greater part of the sticky surface has been covered by dust. The slides are removed and a small amount of a thin solution of Canada balsam applied over the trace by means of a wire The slides are located in their former position and re-exposed: in this manner a dense linear trace is built up. The slides are then removed and covered with a coverslip supported on a spacing ring. Should one plate become heavily coated compared with the other three, it is removed, and replaced by an ordinary slide made adhesive with balsam, and the sampling continued until the rest have reached the desired density.

Immediately after the dense sample has been taken, another sample for counting is obtained, and this enables the size range on each plate to be determined

To obtain the X-ray diffraction pattern, the cover-slip and glass slide are removed, and the linear trace on the foil treated by the usual powder methods.

This method would seem to have the following advantages over previous methods for determining the variation in composition with particle size:

(1) The sample undergoes no treatment before the diffraction pattern is obtained. Even low-temperature ashing of filter samples may alter the crystal structure, while the possibility of chemical reaction when aqueous media are used in size separations is always an uncertain factor. (2) Coagulæ are deposited in the range appropriate to their Stokes law size—in the same manner as they would be in the breathing passages. Elutriation methods of size separation redisperse coagulæ into their ultimate particles, thereby producing erroneous results. (3) The sample obtained is representative of the dust in a considerable volume of air (5 cu. ft. in the samples so far taken). (4) There is no question of selective coating of the sample placed in the diffraction camera. This is of importance when flaky materials such as micas are present

This method compares favourably on a time per sample basis with elutriation methods, and seems suitable for the study of aerosols consisting of mixed silicates and silica.

Thanks are expressed to Dr. A. Woods of the National Physical Laboratory for help and advice.

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Nov. 16.

[1] May, K. R, *J. Sci Instr.*, **22**, No. 10 (1945)

Response Curve of the Yellow Receptors of the Human Fovea

THE micro-stimulation apparatus[1] has been used recently for studying the shapes of the response curves of some of the receptors which take part in human foveal colour vision. It will be remembered that Granit found evidence for seven kinds of 'modulator' in the retinæ of such animals as frogs, snakes and rats, which had maximum responses at the following approximate wave-lengths: 6000, 5800, 5400, 5200, 5000, 4600 and 4400 angstroms. All these had narrow response curves. In the cat, on the other hand, the response curves appeared to be wider, having legs which were farther apart. Particularly was this the case with the 'modulators' produced from 'dominators' after the retina had been exposed to red, to green, or to blue lights.

Now the three-colour theory of Thomas Young postulates three kinds of modulator in the human fovea . red, green and blue (or violet), and supposes, moreover, that these have very wide response curves indeed, which spread in each case over, roughly, half the visible spectrum. The question that arises, therefore, is: Does man resemble the frog, in having receptors with very sharp response curves ? Or does he resemble the cat, in having receptors with somewhat broader response curves ? Or, is he unique in possessing three types of receptor only, having exceptionally broad response curves ?

I have found two methods of obtaining the response curve of one of the receptors of the human fovea, both depending on a study of the antichromatic responses.

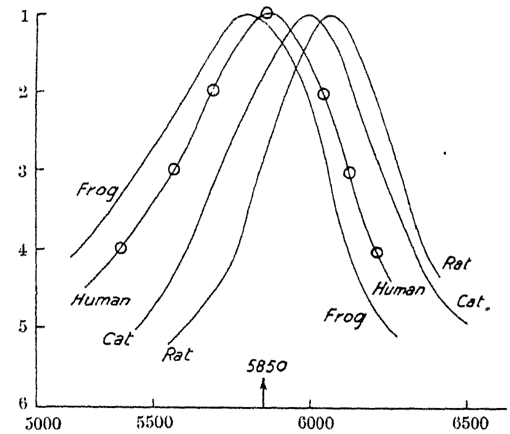

Fig 1

THE CURVES FOR THE RECEPTORS OF THE FROG, THE RAT AND THE CAT WERE OBTAINED BY PROF. GRANIT THE HUMAN CURVE WAS OBTAINED BY THE AUTHOR

(1) It was found that when a yellow test-object has been sufficiently reduced either in intensity or in visual angle, it is replaced by white. But if a second yellow object is placed near the first, in the visual field, the latter is seen to become yellow again If the second conditioning object is not yellow, but some other colour, then it facilitates the reversion of the first to yellow if it reflects yellow rays, but not otherwise. This effect was employed for obtaining the shape of the response curve of the yellow human foveal receptor, in the following way. Two point sources of light of about the same brightness were presented to an observer by means of the micro-stimulation apparatus. One of these was a yellow test light of fixed intensity, produced by suitable colour filters. The other was a conditioning light, produced by a monochromator, which could be altered in both wave-length and intensity. It would have been better for both sources to have been produced by monochromators, but unfortunately only one was available. The intensity of the conditioning source having been adjusted, the wave-lengths were determined, first in the orange, and then in the yellow-green, at which the test-source underwent a transition from yellow to white. When the conditioning source had a high intensity, a considerable difference in wave-length was necessary; but as the intensity was reduced, the wave-lengths approximated more and more to one another, until finally they became identical. When the wave-lengths were plotted against the log of the intensity, the curve shown in Fig. 1 was obtained. In the same diagram are also plotted three typical response curves, as found by Granit for the retinæ of animals Granit's method of obtaining response curves differs radically from that used by me, so also do the data on which the curves are based; none the less, the similarity between the two kinds of curve is striking.

(2) When either the visual angle or the light intensity, or both, are made small, normal foveal colour vision is replaced by reduced foveal colour vision, which is a form of dichromatism in which orange-red is one primary and greenish-blue is the other. During this change, yellow is replaced by white, and blue by dark grey or black Consequently, since the luminosity curves indicate the total effect at different parts of the visible spectrum of all the photo-receptors which are in operation, the luminosity curve for reduced foveal vision should differ from that for full foveal vision, at two spectral regions, namely, yellow and blue. In both these regions the curve for reduced vision should fall below that for full vision. But further, a study of these curves should give an indication of the magnitude of the changes which have taken place. In Fig. 2 are given three curves: (*a*) for the light-adapted fovea, as shown in Fig. 50, on page 83, of Wright's book, "Researches on Normal and Defective Colour Vision"; (*b*) for the fovea for a 20-min. test-object at a low intensity of illumination, as shown by Wright in *Nature*, **151**, 726 (1943); (*c*) the differences of the ordinates of (*a*) and (*b*) at different wave-lengths. The latter curve should indicate the shapes of the response curves for the yellow and the blue receptors. The former is shown clearly, but the latter is too near the base line for any definite conclusions to be reached about it.

If the response curves for the yellow receptor given by methods (1) and (2) be compared, it will be seen that, while they are of the same general form, they are not identical. Both are alike in one important respect, namely, in reaching maxima at about 5850 angstroms; also both indicate the presence of a modulator with the very narrow type of response curve, similar to those found by Granit in the retinæ of many lower animals. The differences between the response curves given by the two methods may be due to several factors. Thus in the first method, the retinal area under investigation was many times smaller than that used for the second method.

In spite of these differences in detail, the following conclusions appear to be justified: (1) there is present, in the human fovea, a receptor with a sharp response curve in the yellow region of the spectrum; (2) that this has a peak at, or near, 5850 angströms; (3) this receptor takes part in the antichromatic responses, being responsible for one of the changes which affects colour vision when the intensity or the visual angle is reduced.

Method (1) has been used for investigating the other receptors present in the human fovea. There is a receptor having a response curve in the red and another in the green. Both these resemble the one in the yellow, in having narrow response curves. Lastly, these three appear to be too sharp for the light-adapted luminosity curve to be produced by their summation, thus indicating the presence of other receptors in the long-wave region of the visible spectrum. This conclusion is in agreement with that

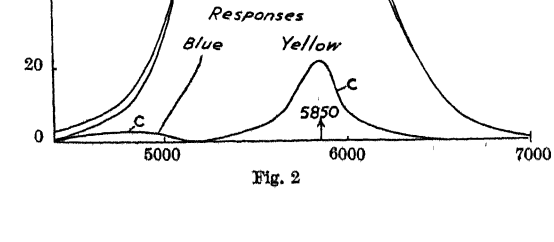

Fig. 2

recently arrived at as the result of employing other methods of micro-stimulation.

The evidence so far available seems to point to the receptors responsible for human colour vision being very like those found by Granit in lower animals. The response curves are narrower than those found in the cat. The position with regard to dominators having broad response curves is far from clear. The evidence seems to be that all modulators become dominators when the light intensity or area of stimulation is sufficiently reduced. The details of this change, if indeed it takes place at all, and the means by which it is brought about, will require further investigation.

Note added in proof.—Since the above letter was written, Prof. Granit has sent me some curves showing the responses obtained after selective adaptation in cats. These occupy the red, yellow and green parts of the spectrum, with maximum sensitivities at 6000, 5800 and 5400 A. respectively. The response curve for the yellow receptor is very similar in shape, and reaches a maximum at almost the same point as that obtained by me for the human fovea, which is shown in Fig. 1.

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[1] To be described in *Phil. Trans. Roy. Soc.*

A Quantitative Study of the Toxic Action of Quinones on *Planaria gonocephala*

THE purpose of the experiments to be described in this paper have been : (1) to continue studies on the mechanism of the antibiotic and toxic effects of certain quinone derivatives[1]; and (2) to extend earlier investigations[2] and to study the so-called axial gradients in a quantitative way. *Planaria gonocephala* was chosen as a suitable model organism for both purposes. Eleven different quinone derivatives have been tested.

Where solubility allows a sufficiently high concentration (*p*-benzoquinone and toluquinone), progressing from higher to lower concentrations of quinones, a marked change from a fixation-like effect to a histolytic one is found in Planarians.

As log-log plotting of mean values of death-times shows, the effect of concentration follows the equation

$$\log t = \log b + a \log \frac{1}{c}, \quad \text{or} \quad tc^a = b,$$

where t is time, c is concentration, a and b are constants.

There is a break in the curve at about 1/1,000 molar concentration, corresponding to the transition from fixation to histolysis, where $a > 1$ for the former, $a < 1$ for the latter effect. Where solubility does not allow a sufficiently high concentration, of course, the second (histolytic) part of the curve is the only one present. Examples of these curves are given in Fig. 1; the other substances give similar curves. Two naphthoquinone derivatives behave differently; $a > 1$ in the histolytic curves of lawson (2-hydroxy-1,4-naphthoquinone) and *iso*-naphthazarin (2,3-dihydroxy-1,4-naphthoquinone). A possible explanation for this exceptional behaviour is that these two substances can react in two tautomeric forms (as *ortho*- and *para*-quinone derivatives), and that the effect described is due to a change in the adsorption equilibrium of these two forms, corresponding to the change of concentration.

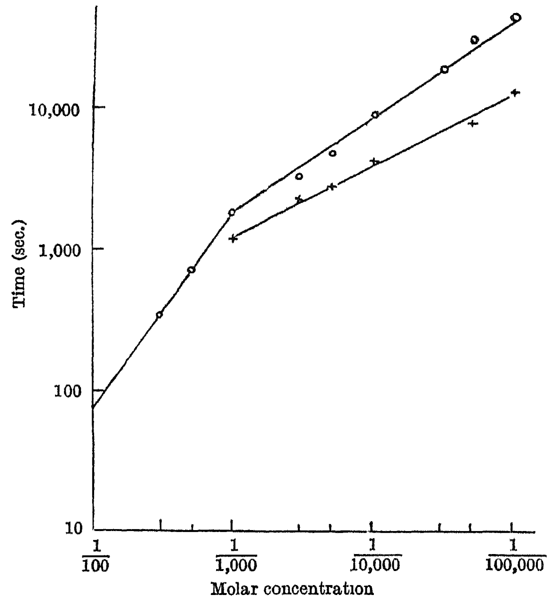

Fig. 1. Curves of death-times; —o—, *p*-benzoquinone; —x—, *p*-naphthoquinone

No investigations, as yet, have been made of the action of quinones on lower animals, but there are many records of the antibacterial effects of these substances[3]. Two theories of the mechanism of these effects have been published. E. A. Cooper[3] explains the antibacterial action of the quinones as a kind of tanning reaction between bacterial proteins and quinones; K. Wallenfels[4], on the other hand, believes that the antibiotic effect is due to an inhibition of certain enzymes necessary in bacterial metabolism. In Planarians, the break in the curve obviously indicates a change from one predominant mechanism to another. The fixation-like effect is, doubtless, due to a protein reaction; whereas for the histolytic one no satisfactory chemical explanation can be given. Similar effects have been described by Herzog and Betzel[5] in disinfection and interpreted as polymerization and adsorption respectively, but in our case polymerization does not seem probable.

Toxicity of the quinones used in the experiments decreases in the following order: naphthazarin, 1,4-naphthoquinone methyl-naphthazarin, *p*-benzoquinone, toluquinone, 1,2-naphthoquinone, 2,6-dimethoxy-benzoquinone, *p*-xyloquinone, 4-methoxy-toluquinone, *iso*naphthazarin, lawson. As the constant a is specific for each quinone derivative, there are some slight changes of this order at extreme concentrations.

Detailed investigation of histolysis in the different regions of the Planarian body leads to a serious criticism of the well-known theory of physiological gradients of Child[6]. As stated before[2], even in a simple organism like a Planarian, there seems to exist not a uniform axial gradient, but rather a bundle of gradients of different kinds and directions. This is confirmed by the present experiments in a

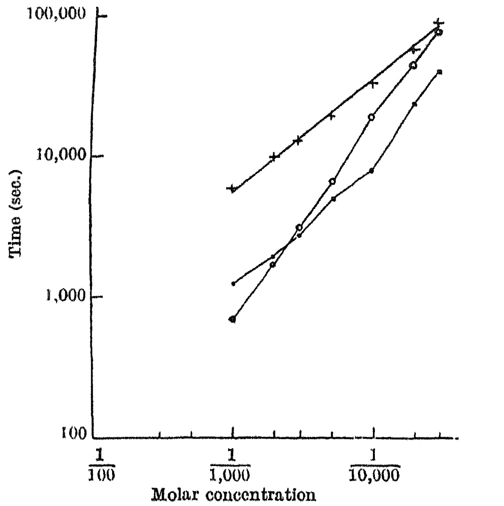

Fig. 2. —x—, curve of death times; —●—, curve of decay beginning at anterior region; —o—, curve of decay beginning at posterior region. Toxic agent: 4-methoxy-toluquinone

very striking manner. In higher concentrations of quinones, decay begins at the anterior region, in lower concentrations at the posterior region; so there is a certain concentration where an inversion of gradient occurs. An example is shown in Fig. 2. This indicates that at least two complexes of factors are involved in the histolytic process, the first being primarily effected by higher, the second by lower, concentrations.

Full details of the results obtained will be published elsewhere.

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Action of Fluorine on the Teeth of Rachitic Rats

In previous communications, it has been shown that the action of fluorine on the dentin of the rat's incisor tooth depends on the Ca : P ratio of the diet[1]. With low Ca : P ratio diets, fluorine causes a fine hypercalcified line in the predentin forming at the time of the injection, but on normal or high Ca : P ratio diets, this does not happen, and the effects of fluorine on the predentin are not seen until it starts to calcify. It was suggested that this difference was due to the differences in the blood calcium level, as this is low with low Ca : P ratio diets and normal or high with the other diets. This supposition has been tested in two ways: by raising the blood calcium of animals on the low Ca : P ratio diet, and by lowering the blood calcium of animals on the high Ca : P ratio diet, and observing the effects of fluorine after this has been done.

Four litters of young rats were placed on a diet of low Ca : P ratio (0·25 : 1), similar to that previously used, for 28 days. Three different procedures were then adopted: some were dosed with 27 I.U. of vitamin D by mouth and given an injection of sodium fluoride solution two days later; some were given only an injection of sodium fluoride solution, and some were only dosed with vitamin D. The rats were killed at intervals up to eight days after the sodium fluoride injection. Whereas the incisors of the rats given sodium fluoride alone all had the usual line in the predentin, the teeth of those previously given vitamin D showed either nothing at all or else an extremely faint line in the most proximal predentin. One litter was given a rather larger dose of sodium fluoride than usual; all the rats getting sodium fluoride alone died in tetany, but those given vitamin D before injection had no tetany and survived. It has been shown[2] that vitamin D dosage in rats on this diet causes a transient rise in blood calcium lasting 4–6 days.

Young rats from three litters were placed on the Steenbock and Black rachitogenic diet (Ca : P ratio, 4 : 1) for 28 days, and were then starved for 1, 1⅓, 1⅔, 2 or 3 days. At the end of this time some were killed as controls and the rest given injections of sodium fluoride and returned to the diet. Many of the rats had violent tetany after the period of starvation, accentuated by the injection of fluoride, and two died. The rest were killed at intervals and examined. The four rats starved for one day showed no changes in their teeth due to the injection of fluoride. Of the other injected rats, two starved for 1⅓ days, and all the other rats, fifteen altogether, had the same hypercalcified line in the predentin as had previously been found in rats on the low Ca : P ratio diet given an injection of fluoride. Measurements showed that the line was laid down at the time of injection, and that the average incremental rate of predentin formation after that was 6 μ per day. As is well known[3], starvation causes a fall in the blood calcium of rats on high Ca : P ratio diets, often to tetanic levels.

Thus under conditions when the blood calcium is raised, the action of fluorine on the predentin is greatly lessened or prevented, while when the blood calcium is lowered, this effect of fluorine is caused in rats previously found not to show it. These observations strengthen the theory previously put forward that the action of fluorine on the teeth is related to the level of the blood calcium.

The expenses of this work were defrayed by grants from the Council for Scientific and Industrial Research, and from the Staff Research Fund, University of Cape Town.

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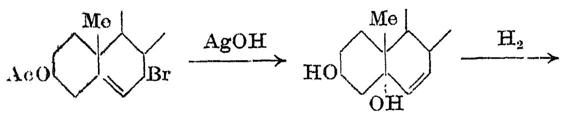
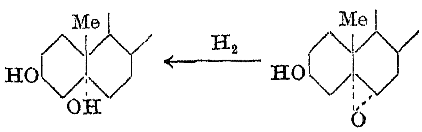
Etherifications Accompanying Girard Treatment for the Separation of Ketonic Substances

THE reagents devised by Girard and Sandulesco[1] for the separation of ketonic substances are widely employed in a variety of fields, especially for the isolation of ketonic steroids. Although the conditions under which these reagents are normally employed are comparatively mild, it has now been shown that, in certain cases, etherification of reactive alcohols can occur.

During the investigation of the reactions of 'β'-7-bromocholesteryl acetate[2] (I), we have discovered that one of the products obtained by alkaline hydrolysis is Δ^6-cholestene-3-(β) : 5(α)-diol (II). This compound, m.p. 181°, is readily hydrogenated to cholestane-3(β) : 5(α)-diol (III), previously prepared[3] by hydrogenation of α-cholesterol-oxide (IV).

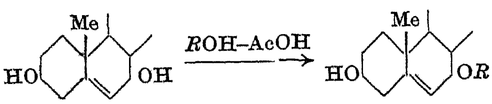


(I) (II)

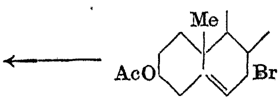


(III) (IV)

Only two Δ^6-cholestene-3(β) : 5-diols, differing in configuration at C_5, can possibly exist, and two such 'diols' had already been tentatively assigned this structure. Bergström and Wintersteiner[4] obtained a compound, m.p. 138°, from 'β'-7-hydroxycholesterol (V) by refluxing in ethanol containing 10 per cent of acetic acid. Prelog, Ruzicka and Stein[5] isolated a compound, m.p. 155·5–156°, from the non-saponifiable portion of extracts of pig spleen, which they suggested might be an isomer of the Bergström and Wintersteiner diol. The reactions of these two substances were consistent with the formulations suggested, but in neither case was any rigorous structural proof obtained, for example, by hydrogenation, etc.



(V) (VI)



(I)

We have now shown that the former compound is actually 'β'-7-ethoxycholesterol (VI; R = Et), formed by a facile acid-catalysed etherification reaction; substitution of methanol for ethanol in this reaction gives 'β'-7-methoxycholesterol (VI; R = Me), m.p. 158°. These formulations are supported by analytical data, including methoxyl and ethoxyl determinations.

Treatment of 'β'-7-bromocholesteryl acetate (I) either with sodium methoxide or with silver nitrate and methanol, followed by alkaline hydrolysis, also yields 'β'-7-methoxycholesterol (VI; R = Me). It was observed that its physical constants and those of its acetate and benzoate were in close agreement with those of the supposed diol obtained from pig spleen[5], and mixed melting point determinations, kindly carried out by Dr. Prelog, confirmed the identity of the products.

Bergström and Wintersteiner[4] first isolated what has now been shown to be the 7-ethoxy-compound, following the Girard separation of the ketonic and non-ketonic materials obtained by aerial oxidation of cholesterol, the separation being effected in the usual manner in *ethanol* solution in the presence of acetic acid. Although these workers realized that the 7-hydroxy-compound had undergone some change during the treatment, their supposition of an isomerization reaction was incorrect. Prelog *et al.*[5,6] employed the Girard reagent in *methanol*, and it is reasonably certain that the 7-methoxy-steroid does not occur in the natural material, but that it is formed during the Girard separation from 'β'-7-hydroxycholesterol originally present in the extract.

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Analysis of Boron Trifluoride: a Double Compound of Silicon Tetrafluoride and Trimethylamine

IN connexion with nuclear cross-section studies in which boron trifluoride was used as a reference gas, a method of analysis of this gas was devised based on the condensation of boron trifluoride with acetyl fluoride to form acetyl fluoborate. This material is involatile at − 120° C., and volatile impurities from the boron trifluoride can easily be pumped off and their volume determined[1].

During these studies, particular attention was paid to silicon tetrafluoride as the most likely volatile impurity remaining in the gas after two fractional distillations *in vacuo* at − 160° C.

The volume of the sample of boron trifluoride to be analysed was determined in a calibrated bulb attached to the vacuum apparatus, in which mercury cut-offs were used throughout in place of stopcocks. It was then frozen out in liquid nitrogen in a bulb attached to a 300-c.c. reaction vessel, and an excess of acetyl fluoride prepared by the method of Nesmejaow and Kahn[2] afterwards condensed in the same trap. On warming, the gases volatilized and reacted. The contents of the vessel were pumped out slowly through an efficient liquid-nitrogen trap, the temperature of the condensate was raised to − 120°, and the silicon tetrafluoride collected and its volume determined. Tests of the efficiency of the method, using synthetic mixtures of BF_3 and SiF_4 in proportions 2 . 1, showed that recovery of the silicon tetrafluoride was always more than 99 per cent complete. From these results it was estimated that 0·2 per cent of impurity could be detected in 200 c.c. of boron trifluoride using this particular apparatus, which was not specifically designed for this purpose and had an unnecessarily high internal surface volume ratio.

The use of trimethylamine as a condensing agent for the boron trifluoride, which was first tried, was found to be impracticable owing to the formation of a double compound with silicon tetrafluoride which has not previously been reported. It is characterized by the following procedure.

30·3 c.c. of silicon tetrafluoride which had been freed from hydrogen chloride by careful fractional distillation *in vacuo* at $-150°$, together with 80·8 c.c of trimethylamine dried by passage over phosphorus pentoxide, were condensed in a trap cooled by liquid nitrogen. On permitting the mixture to warm up and volatilize, a cloud of white solid was produced, and analysis of the gas remaining revealed that this consisted of 49·1 c.c. excess trimethylamine. The gaseous reactants had thus combined in the volume ratio $NMe_3/SiF_4 = 1·04$. A later experiment using an excess of silicon tetrafluoride gave a volume ratio $NMe_3/SiF_4 = 1·01$. It therefore appeared that these two gases had formed an equimolecular double compound, which proved to have a dissociation pressure of about 45 mm. at room temperature, and 0·1 mm. at $-78°$ C.

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Checking of Sir James Jeans' Numerical Calculations

IN the preface to his "Introduction to the Kinetic Theory of Gases", 1940, the late Sir James Jeans intimates that I had checked "all the numerical calculations" in the fourth edition (1925) of his "Dynamical Theory of Gases". It should, however, be stated that as a rule I only checked one or two of the items in the tables. As regards these and the numerical results given in the text, I did indeed as a rule agree, at least approximately, with Jeans' figures; but in a few cases, some of which are to be mentioned in a forthcoming note in the *Philosophical Magazine*, my results differed substantially.

Another quite distinct point is that, in the third edition (1933) of his book "The Universe Around Us", Sir James Jeans credits me on page 254 with a theory of the tidal origin of the planets which may seem to adumbrate his own theory. But whereas I did in effect suggest that the outermost planet might have been produced by the tidal action of a passing star on the nebulous sun, assumed to extend to the planet's orbit, I supposed that the remaining planets were each produced in succession by the tidal action of the nearest existing planet on the contracting solar body. This supposition must, however, be abandoned if the assumed extension of the sun is untenable.

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'Velsicol 1068'

Kearns, Ingle and Metcalf[1] have recently commented on the properties of a chlorinated hydrocarbon of empirical formula $C_{10}H_6Cl_8$ which was described as "possibly a mixture of isomers which as yet have not been resolved and evaluated individually". In a note[2] on this new insecticide it has been stated that in solubility the compound, to which the trade name 'Velsicol 1068' has been assigned, resembles D.D.T. and benzenehexachloride. It seems desirable to direct attention to the fact that unlike the two latter compounds, we have confirmed the observation of Kearns and co-workers[1] that the new compound is soluble in all proportions in most organic solvents, including deodorized kerosene. This property is of considerable importance in formulating products for test purposes. It appears that apart from the results of Kearns and co-workers[1] little has been published on the insecticidal efficacy of 1068, but these workers presented results to support their statement that "(1068) was found to be more toxic than D.D.T. and to compare favourably in toxicity to the pure γ isomer of benzenehexachloride"[3].

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A Revival of Natural Oyster Beds

IN *Nature* of October 26, p. 586, Dr. P. Korringa has discussed the problem of reviving natural oyster beds. In general, I agree with his views; but I should like to add some comments on the origin of the oysters used when trying to revive a depleted bed.

In the south-eastern part of Norway, we often have great mortality among oysters reared in netting trays. This mortality, however, only affects oysters taken as spat from districts with different hydrographical conditions. Oysters from spat spawned in the same waters have never failed. When we first noticed this, we believed that the spat from other districts might have been damaged during transport. But if this was the case, the mortality should be greatest shortly after arrival. Heavy mortality can, however, take place a year or two after transplantation; although in the same locality the native oysters flourish.

We are inclined to believe that oysters from the western coast of Norway are not able to stand the rather large variations in salinity occurring on the Skagerrack coast.

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ABSORPTION SPECTRUM OF HÆMOGLOBIN IN RED CELLS

By D. L. RUBINSTEIN and H. M. RAVIKOVICH
Central Institute for Hæmatology and Blood Transfusion, Moscow

SOME years ago Macallum, Bradley and Adams[1,2] discovered that the absorption spectrum of red corpuscles is entirely devoid of the γ- or Soret-band—the broad absorption band of hæmoglobin located between 400 and 430 mμ—whereas the α- and β-bands in the visible part of the spectrum remain unaltered. This band appears only after hæmolysis, when intraglobular hæmoglobin becomes free and passes into solution. This phenomenon has since been confirmed by Keilin and Hartree[3].

These authors, however, do not support Adams's[4] contention that the disappearance of the γ-band is due to intraglobular hæmoglobin being chemically bound to stromatin. Especially convincing were experiments in which they had obtained a similar obliteration of the γ-band by emulsifying minute droplets of a hæmoglobin solution in paraffin or castor oil. It has been inferred that the disappearance of the γ-band—both in intact red cells and in the hæmoglobin–oil emulsion—is a purely optical phenomenon. However, no plausible explanation of this peculiar phenomenon could be suggested.

In a previous investigation carried out in collaboration with Iljina and Shpolsky[5], we managed to detect the vanished γ-band in intact red cells by means of a spectro-photo-electric technique. The important point was to adjust the cuvette with the red cells quite close to the photocell, thus gathering on its surface the major part of rays scattered by the suspension. This can be easily achieved by means of a selenium photocell because of its flat surface, the absorption curve scarcely differing in this case before and after hæmolysis (Fig. 1). If an antimony–cæsium photocell is used, a considerable part of the scattered light is prevented by its spherical bulb from reaching the photosensitive layer. As a result, the γ-band in the spectrum of intact red cells, although still distinct, is obviously dimmed (Fig. 2).

In the same investigation a spectrographic technique for detecting the vanished γ-band has also

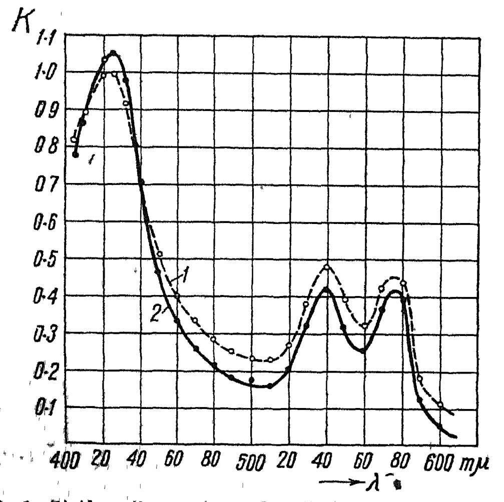

Fig. 1. (1) Absorption spectrum of a red-cell suspension; (2) the same after hæmolysis. Selenium photocell

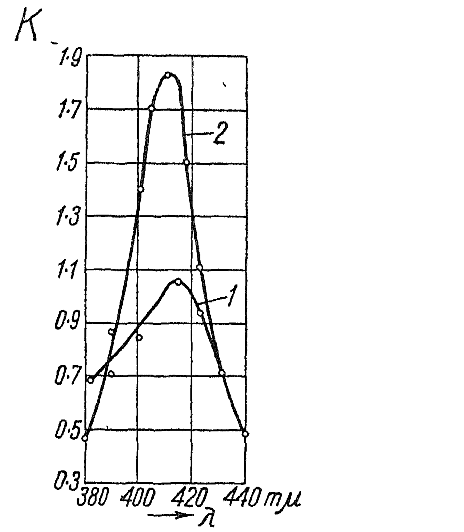

Fig. 2. γ-Band in absorption spectrum of a red-cell suspension (1) before (2) after hæmolysis. Antimony–cæsium photocell

been devised. Instead of the usual set-up, a light beam was directed on the cuvette with the red-cell suspension at a small angle (not greater than 40–45°) to the optical axis of the spectrograph. Only the light that is scattered in a backward direction was thus allowed to reach the collimator: it displayed the γ-band specific for hæmoglobin.

In the present investigation a further analysis of the Macallum–Bradley–Adams phenomenon has been attempted. It is obvious that the obliteration of the γ-band thus far observed is a phenomenon of light scattering. But the scattering of light in a turbid disperse system depends upon a large difference in the refractive indices of both its phases. This provides a means of experimentally controlling the phenomenon under investigation.

The experiments of Keilin and Hartree mentioned above have been repeated and their results wholly confirmed. Indeed, the γ-band disappears completely even if the hæmoglobin solution is emulsified in oil in a much greater proportion than in these authors' experiments (for example, 1 part of a 1·6 per cent hæmoglobin solution dispersed in droplets of 1–7 μ in diameter per 4 parts of 'Vaseline' oil). However, the γ-band in the spectrum of the hæmoglobin emulsion could be detected by a simple procedure.

This could be achieved by adding concentrated sucrose to the hæmoglobin solution before emulsifying it in oil. A syrup containing 70 gm. sucrose per 100 gm. solution has approximately the same refractive index as our 'Vaseline' oil, namely, 1·49. It has been shown by photometric measurements that the addition of such a high sucrose concentration reduces the turbidity of a water-in-oil emulsion to a small per cent of its initial value. The γ-band, that was entirely obliterated in the hæmoglobin–oil emulsion, becomes perfectly distinct if the hæmoglobin droplets have been saturated with sucrose (Fig. 3).

An attempt has been made to apply a similar technique to red-cell suspensions. This was not easy, since most of the substances that could raise the refractive index of the solution would, at the same time, hæmolyse the red cells. The best results were finally obtained by means of a dextrin preparation, a refractive index $n_D^{20} = 1{\cdot}40$ corresponding to a

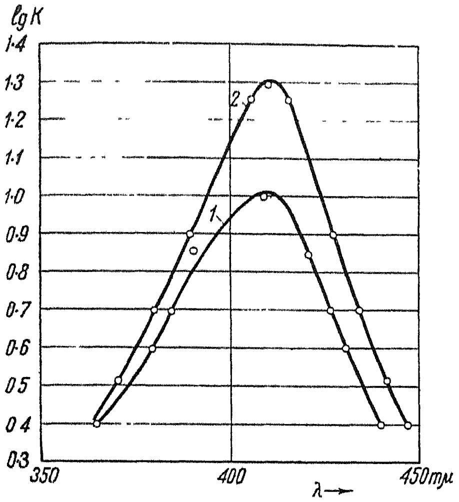

Fig. 3. (1) γ-Band in absorption spectrum of a sucrose–hæmoglobin solution (68 per cent sucrose) emulsified in 'Vaseline' oil; (2) γ-band of oxyhæmoglobin. Hydrogen tube, Zeiss quartz spectrograph "für Chemiker", Hilger microcell

concentration of 70 gm. dextrin in 100 c.c. solution. This is, of course, far from reaching the refractive index-level of the red cells (which would have resulted in producing 'laked blood' without hæmolysis). But the discrepancy between the two refractive indices is smoothed sufficiently, thereby considerably increasing the transparency of the suspension and distinctly revealing the γ-band (Fig. 4). This effect is certainly not due to hæmolysis, since the γ-band disappeared again upon diluting the suspension tenfold with physiological saline.

The experiments described throw some light on the mechanism of the obliteration of the γ-band in the absorption spectrum of red corpuscles. A tentative explanation of this phenomenon follows.

In a red-cell suspension we must distinguish between two kinds of scattered rays corresponding to the two interfaces on which light scattering occurs. Light rays may be scattered on passing from the medium into the hæmoglobin-carrying particle, and are in this case evidently devoid of any specific absorption bands. Rays of the second type enter the disperse particle and are scattered on passing from it back to the dispersion medium. If the latter has a smaller optical density than the particle (for example, a corpuscle suspension in physiological saline), a part of the rays undergoes thereby a complete interior reflexion. The scattered rays of the second type naturally possess all the spectral bands specific for the dispersed substance.

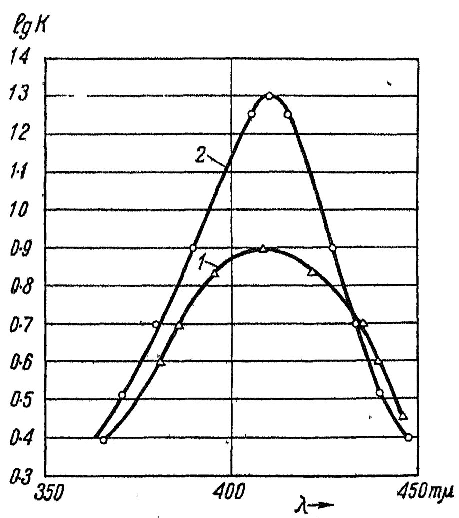

Fig. 4. (1) γ-Band in absorption spectrum of a red-cell suspension in a dextrin–saline solution (70 per cent dextrin dissolved in physiological saline); (2) γ-band of oxyhæmoglobin. Hydrogen tube, Zeiss quartz spectrograph "für Chemiker", Hilger microcell

The proportion of scattered rays of these two types depends upon the angle at which the light beam is scattered by the suspension. Rays of the first type are scattered mostly forward in the direction of the entering beam. They prevail, therefore, in the narrow light beam passing through the red-cell suspension when the usual spectrographic technique is applied —leading, in this case, to the disappearance of the γ-band. As the angle at which light is scattered becomes larger, there appears an increasing proportion of scattered rays of the second type, namely, of such rays as have traversed the interior of the red corpuscles, undergoing selective absorption in them. As has been previously described, their investigation reveals in the absorption spectrum of red corpuscles the γ-band otherwise lacking.

The effect depends largely upon the wave-length of scattered light. Being of no importance in the visible part of the spectrum (bands α and β), its role becomes prominent in the ultra-violet.

[1] Macallum, A. B., and Bradley, R., *Science*, **71**, 341 (1930).
[2] Adams, G., Bradley, R., and Macallum, A. B., *Biochem. J.*, **28**, 482 (1934).
[3] Keilin, D., and Hartree, E. F., *Nature*, **148**, 75 (1941).
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[5] Iljina, A. A., Ravikovich, H. M., Rubinstein, D. L., and Shpolsky, E. V., *C. R. Acad. Sci.*, U.S.S.R., **48**, No. 5, 325 (1945).

THE BRITISH COUNCIL

ANNUAL REPORT

ALTHOUGH it is not easy in the absence of any financial statement to judge from the report of the British Council for the year ended March 31 as to how far the activities of the Council are now in balance either geographically or functionally, the report gives a convincing answer to some of the more captious criticisms, and in particular it is possible to assess from it how large a contribution the Council is making to the interchange of knowledge. Geographically, the most interesting feature of the report is the account of the activities of the Council in liberated Europe and the intense demand for British books and for information regarding Britain in Austria, Czechoslovakia, France, Hungary, Greece, Italy, Holland, Belgium, Poland, Sweden and Yugoslavia. Work in Latin America has also gone ahead, but in the colonies, protectorates and mandated territories there has been consolidation rather than expansion. With the withdrawal from the United Kingdom of large numbers of Allied troops and civilians, the work of the Council at home changed considerably. Leave courses gradually diminished, but the scholarship programme was considerably extended, 405 being offered as against 115 in 1944, and some 307 holders of British Council scholarships arrived in the United Kingdom during the year. A Students' Welfare Department was established to supervise the general welfare of such students and certain other students from overseas and to offer them facilities for study, travel and recreation. Lecture courses for such students and other overseas visitors, an information services department, exhibitions and a series of informative pamphlets are among the ways in which the Council has sought to help overseas visitors to understand the British way of life.

Turning to the functional activities, the greater part of the book grant has been concentrated on building up British Council libraries, especially in liberated Europe. The book review scheme was extended to cover many new countries, and circulation of *British Books to Come* was doubled, the periodical now reaching sixty-three countries. Forty-one brochures in twelve languages were published. Although the Book Export Scheme introduced in 1941 largely as a war-time measure has been withdrawn, the Council's book copyright work has largely increased. The Council was also instrumental in allocating and distributing to numerous learned institutions back sets of periodicals given by individuals, learned societies and publishers, and as a further step towards overcoming the shortage of back sets of periodicals and filling the gap in information caused by the War, it has arranged for the indexes and contents list of sixty specialist journals for the years 1939–45 to be microfilmed. One set of these microfilms will be lodged in each of fourteen European countries and in China, either in the principal library where a microfilm reader is available, or in the Council's library. Much information about publications now available in Europe has been obtained for British organisations, and 533 new exchanges between British and foreign periodicals, involving thirty-nine different countries, were arranged during the year.

The total distribution of *Monthly Science News* was about 70,000 at the end of March, and the distribution of articles on engineering and technology was continued, 113 sets going to thirty-nine countries. The Information Section was fully occupied, chiefly with bibliographical inquiries, and requests from Moscow for books, papers, and other scientific information considerably increased. An exhibition of British medical books published during the War was held in Moscow, and articles sent to Moscow for publication included a series on the work of the Department of Industrial and Scientific Research. Scientific supplies to China considerably increased during the year, and the report refers to the lasting impression on the Chinese people made by the Council's staff during the last three and a half years under Dr. Needham's direction.

The *British Medical Bulletin* has now reached its fourth volume, and sets of volumes 2 and 3 were sent to liberated Europe as soon as possible. A selection of articles from the *Bulletin* made by members of the Medical Faculty of Leyden was published in January 1946 as a book under the title "Recent Medical Science, 1940–5". About five hundred foreign and Empire medical journals are now received in exchange for the *Bulletin*, in addition to others received for the Medical Library, while fifty medical films were reviewed for distribution overseas.

The engineering consultant, Prof. S. J. Davies, visited Greece in the autumn of 1945 to investigate questions affecting engineering and scientific education, particularly the arrangement of courses, the equipment and libraries available, and the distribution of British technical books and periodicals. In conjunction with the librarian of the Science Department, the Agricultural Department prepared a handlist of British Biological Societies and Journals, and a corresponding list covering agricultural societies and journals is in preparation. An agricultural officer was appointed to the Council's staff in Turkey, and original articles were supplied for the *British Agricultural Bulletin* published in Turkey.

In addition to the scholarship programme already mentioned, the educational services of the Council include the recommendation, at the request of universities, schools and other educational institutions overseas, of suitable British candidates for vacant teaching posts in English language and literature, in British history and institutions and on other subjects. A list of such appointments made or recommended during the year is given in the report, as well as a note on three specialized vacation courses provided in the summer of 1945: a two weeks special electrical engineering course at Queen Mary College, London; a residential course on "Britain, its System of Government, of Education and of Life, and its Ideals of Empire" at the University of St. Andrews; and a residential course, at Wadham College, Oxford, in conjunction with the Oxford University Delegacy for Extra-Mural Studies.

IRON AGE DISCOVERIES IN CZECHOSLOVAKIA

IN the *Illustrated London News* of October 19 and November 3, Prof. K. Absalon, of Brno, describes the remarkable discoveries made by his grandfather, Dr. Wankel, in the cave of Byči Skala. Wankel's excavations in 1872 have only been described in a popular tourist guide, "Bilder aus der mährischen Schweiz", published in 1882, but have now been supplemented by Prof. Absalon's own operations between 1922 and 1939.

The cave was inhabited in the Upper Palæolithic age and has left stratified relics of a 'primitive Aurignacian', a Gravettian and a long Magdalenian occupation. A completely sterile travertine seals the palæolithic layers and represents a hiatus, corresponding to the Mesolithic, but the cave was reoccupied in Neolithic times and thereafter down to the first Iron Age.

The most significant discoveries of Wankel referred to the last-named occupation. The cave had been used as the workshop of a smith, who doubtless used the rich iron ores of the district. Wankel recovered and described an important series of smiths' tools, including tongs, the earliest dated examples from temperate Europe, but these unfortunately have never yet been illustrated. Absalon figures another discovery that may be of even greater significance, namely, a ring of cast iron. If metallurgical study proves that it was really cast—and Prof. Absalon offers it to his English colleagues for examination—it will be the oldest piece of cast iron from Europe; but without microscopic examination it is actually very difficult to distinguish cast from forged iron.

The smithy was abandoned when use was made of the cave for the burial of an Early Iron Age chieftain, with rites more Oriental than European. Like the occupants of the 'Royal Tombs' of Ur, this Hallstatt chief was conveyed to the tomb on a wheeled wagon which was buried with him, and was accompanied by numerous retainers slaughtered at his obsequies. More than forty human skeletons were found, all but five being those of young women. Numerous animals and enormous quantities of grain were also deposited with the dead, as well as a fine variety of ornaments and implements in bronze and iron, characteristic of the late Hallstatt Age. The body was, however, burned and the site of the pyre covered with a layer of large stones.

The illustrations of the Hallstatt objects in Wankel's book reproduced here are inadequate, and a full publication of the relics is to be desired. Prof. Absalon, however, states that a monograph on the Palæolithic excavations has just been published.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, December 31

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 3 p.m.—Prof. H Hartridge, F R S "Colours and How we See Them" (Christmas Juvenile Lectures, 2) *

Wednesday, January 1

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C.2), at 2.30 p.m.—Mr. Derek McCulloch: "The Children's Hour" (Dr. Mann Juvenile Lecture).

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 5 p.m—Prof. W. V. Mayneord: "The Applications of Atomic Physics in Medicine" (succeeding lectures on January 8, 15, 22, 29 and February 5).

Thursday, January 2

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 3 p.m.—Prof. H. Hartridge, F.R.S.: "Colours and How we See Them" (Christmas Juvenile Lectures, 3).*

ROYAL SOCIETY OF MEDICINE, NEUROLOGY SECTION (at 1 Wimpole Street, London W 1), at 8 p.m. Prof. E D. Adrian, F. S: "General Principles Governing Nervous Activity" (Hughlings Jackson Memorial Lecture).

Friday, January 3

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m—Mr. H G. Conway, Mr. S M. Parker and Mr. D. A. L Robson "The Development of Aircraft Hydraulic Machinery" (Discussion).

Saturday, January 4

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p m—Prof. H. Hartridge, F.R.S. "Colours and How we See Them" (Christmas Juvenile Lectures, 4).*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

EDUCATIONAL PSYCHOLOGIST for the City of Portsmouth—The Chief Education Officer, Education Offices, 1 Western Parade, Southsea (January 4).

PRINCIPAL OFFICER (temporary) to take charge of development of electrical and mechanical earth-moving and road-making plant required by the Army, and SENIOR OFFICERS (temporary) with high qualifications in Civil, Structural or Mechanical Engineering, at the Military Engineering Experimental Establishment, Christchurch, Hants.—The Director of Scientific and Technical Administration (D), Room 27, Ivybridge House, Adam Street, Strand, London, W.C.2, quoting No. D. 2246 (January 6).

[CL]NICAL BACTERIOLOGIST—The House Governor, Royal Victoria [Infirm]ary, Newcastle-upon-Tyne (January 18)

[S]ENIOR LECTURER IN PHYSICS—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C.3.

LECTURER IN ZOOLOGY, and a LECTURER IN MATHEMATICS—The Registrar, University of Tasmania, Hobart, Tasmania.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Welding Research Association. Arc Welded Structural Steelwork, 1: Stanchion Bases, Caps and Joints. Recommendations for the Design, Fabrication and Erection of Welded Stanchion Details Pp. 12. (London: British Welding Research Association, 1946) 9d. [177

Proceedings of the Royal Irish Academy Vol. 51, Section A, No. 2. The Calibration of a Photo-electric Nucleus Counter By P. J. Nolan and L. W. Pollak. Pp. 7-32. (Dublin. Hodges, Figgis and Co, Ltd., London: Williams and Norgate, Ltd, 1946) 2s [187

Imperial Forestry Institute: University of Oxford Twenty-first Annual Report, 1944-45. Pp 16. (Oxford. Imperial Forestry Institute, 1946) [237

Edinburgh and East of Scotland College of Agriculture. Calendar for 1946-1947. Pp. 50. (Edinburgh: Edinburgh and East of Scotland College of Agriculture, 1946) [237

Radio Transmission of Finger Prints By Supt. F. R. Cherrill Pp 12. (London Commissioner of Police of the Metropolis, 1946.) [237

Privy Council Office. Treasury. Report of the Committee on the Provision for Social and Economic Research. (Cmd. 6868.) Pp. 16 (London H M. Stationery Office, 1946.) 3d. net [237

Humane Destruction of Rats and Mice. By Major C. W Hume Pp. 4. (London: Universities Federation for Animal Welfare, 1946.) [237

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, June 1, 1946 Pp. 26. (London: Royal Observatory, Greenwich, 1946) [247

Royal Society Report on the Needs of Research in Fundamental Science After the War. Pp 62 (London: Royal Society, 1945.) [257

Current Affairs (Published fortnightly.) No 8 Food and Farming By the Rt. Hon. Walter Elliot. Pp 20. (London Bureau of Current Affairs, 1946) 8s. 6d per annum. [18

Map Review (Published fortnightly) No 6. From June 13th to June 26th, 1946. 40 in. × 30 in. (London Bureau of Current Affairs, 1946.) 18s 6d per annum. [18

Farm Mechanization Enquiry. Farm Case Study No 1: A Study of a 200 Acre South Warwickshire Clay Farm in relation to its Use of Machinery. By John W Y. Higgs, from the field work of Miss H J Thompson. (Published for the National Institute of Agricultural Engineering) Pp. 20 (London. H M Stationery Office, 1946) 1s net [18

Verticillium on Mushrooms: Consideration of the Commercial Aspect of the Disease, with Notes on its Introduction, Prevention and Control By Fred C Atkins. Pp. 56. (Yaxley, Peterborough. Midlands Group Publications, 1946) 5s. [18

Burton-on-Trent Natural History and Archæological Society. Local Records for 1945. Edited by H J. Wain Pp 24 (Burton-on-Trent H. J. Wain, Hon. Sec., Dunelm, Bretby Lane, 1946.) 1s. [18

The Objects of the Society for Freedom in Science. Second edition Pp 12 (Oxford: Dr John R. Baker, Sec., University Museum, 1946) [18

Institution of Civil Engineers and the Institution of Municipal and County Engineers. Report of Joint Committee on Location of Underground Services. Pp. 12. (London. Institution of Civil Engineers, 1946) 6d. [18

Department of Scientific and Industrial Research. Fuel Research. Technical Paper No. 52 The Extraction of Ester Waxes from British Lignite and Peat. By Dr C M. Cawley and Dr J G. King. Pp. iv+29. (London H.M Stationery Office, 1946) 6d. net. [18

Ministry of Health: Department of Health for Scotland. Report of the Inter-Departmental Committee on the Rag Flock Acts (Cmd. 6866) Pp. iv+36. (London H.M. Stationery Office, 1946.) 9d. net. [18

Royal College of Physicians of Edinburgh. Annual Report by the Curator of the Laboratory for the Year 1945. Pp. 10. (Edinburgh: Royal College of Physicians of Edinburgh, 1946.) [18

Fitzwilliam Museum, Cambridge. Annual Report for the Year ending 31 December 1945 Pp. 10. Friends of the Fitzwilliam Museum. Thirty-seventh Annual Report for the Year 1945. Pp. 4. (Cambridge Fitzwilliam Museum, 1946.) [18

Registrar-General's Statistical Review of England and Wales for the Year 1941. (New Annual Series, No 21.) Tables, Part 2: Civil. Pp vi+92 (London: H M. Stationery Office, 1946.) 1s. 6d. net. [18

Forestry Commission. Bulletin No 18 Spring Frosts, with special reference to the Frosts of May 1935. Second edition. Pp. 111+12 plates (London. H.M Stationery Office, 1946) 2s 6d. net. [18

Engineering Research in the University: the Inaugural Lecture to the Chair of Civil and Mechanical Engineering given in the University of London, Queen Mary College. By Prof. Edmund Giffen. Pp 12 (London Oxford University Press, 1946) 1s. 6d. net [18

Scientific Proceedings of the Royal Dublin Society. Vol 24 (N S), No. 10: Observations on the Pasmo Disease of Flax and on the Causal Fungus *Sphaerella linorum* Wollenweber. By J. B. Loughnane, R. McKay and H. A. Lafferty. Pp. 89-98+plates 2-4. 3s. Vol. 24 (N.S.), No. 11: A Study of *Septoria oxyspora* Penz. and Sacc Isolated from Diseased Barley By Dr. Robert McKay. Pp. 99-110+plates 5-7. 3s. Vol 24 (N.S), No. 12: Studies on Ureides, Part 2, The Chemistry of Triuret and related Compounds. By A E. A. Werner and J. Gray Pp. 111-118 1s Vol 24 (N.S.), No. 13 Evidence for a Mitotic Hormone. Observations on the Mitoses of the Embryo-Sac of *Fritillaria imperialis* By Prof. Henry H Dixon Pp. 119-124+plates 8-10. 2s 6d. Vol. 24 (N S.), No. 14 The Occurrence of Nickel and Magnetite in some Irish Serpentines, in conjunction with a Magnetic Survey. By D W Bishop. Pp 125-134. 1s. (Dublin. Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1946) [18

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 18: The Influence of Mechanical Treatment of Milk and Cream on the Size Distribution of the Fat Globules. By J. Lyons. Pp. 249-272 (Dublin: Hodges, Figgis and Co., Ltd., London. Williams and Norgate, Ltd, 1946) 2s. [18

Forestry Commission. Bulletin No. 17: The Cultivation of the Cricket Bat Willow. Pp. 50+17 plates. (London. H M. Stationery Office, 1946) 2s net. [148

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Ministry of Health: Nurses Salaries Committee: Mental Nurses Sub-Committee. Further Recommendations: Mental Nurses S.C. Notes No. 7. Pp 12. (London: H.M. Stationery Office, 1946.) 2d. net. [148

Ministry of Education · Science Museum Naval Mining and Degaussing · an Exhibition of Representative British and German Naval Mining and Degaussing Material used during the War 1939–1945. Pp viii+27. (London H.M. Stationery Office, 1946) 6d. net. [148

Rural Education and Welfare in the Middle East By H. B. Allen. A Report to the Director General, Middle East Supply Centre, September 1944. Pp vi+24. (London H M Stationery Office, 1946.) 1s 6d net [148

Scientific Instrument Manufacturers' Association of Great Britain, Ltd. Report of the President and Council for the Year 1945–1946 Pp 8 (London · Scientific Instrument Manufacturers' Association of Great Britain, Ltd , 1946) [148

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Commonwealth of Australia Council for Scientific and Industrial Research Bulletin No. 192 . Investigations of Guayule (*Parthenium argentatum* Gray) in South Australia. By R. L. Crocker and Dr. H C Trumble. Pp. 44 + 12 plates (Melbourne: Government Printer, 1945.) [187

Publications of the Kapteyn Astronomical Laboratory at Groningen. No. 51 On the Interstellar Line Intensities as a Criterion of Distance; No 52. The Luminosity Law and Density Distribution of the O and Early B Stars. By Prof. Dr P J Van Rhijn Pp iii + 47 + iii + 25. No 52 A Study of the Scorpio-Centaurus Cluster. By A. Blaauw. Pp iv + 132 (Groningen. Hoitsema Bros , 1946) [187

Dispersion of Small Organisms Distance Dispersion Rates of Bacteria, Spores, Seeds, Pollen and Insects, Incidence Rates of Diseases and Injuries. By D. O Wolfenbarger (Reprinted from the *American Midland Naturalist*, Vol 35, No 1, January 1946.) Pp. 152. (Notre Dame, Ind.: University Press, 1946) [187

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Experimental Research on the Possibility of the Distinction between Plants and Animals according to the Effect of Sulfanilamide upon their Cells. By Dr. Stéphane D. Demetriadès. Pp 16. (Athens Author, 18b Asclipion Street, 1946.) [18

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Bulletin of the Museum of Comparative Zoology at Harvard College. Vol 96, No. 3: The Genera of Fossil Conchostraca, an Order of Bivalved Crystacea. By Percy E. Raymond Pp 215–308+6 plates. (Cambridge, Mass · Harvard College, 1946.) [18

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Contribucion a la historie de la penicilina Por Prof. Dr Florencio Bustinza Pp 51. (Madrid The Author, Universidad de Madrid, 1946.) [148

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